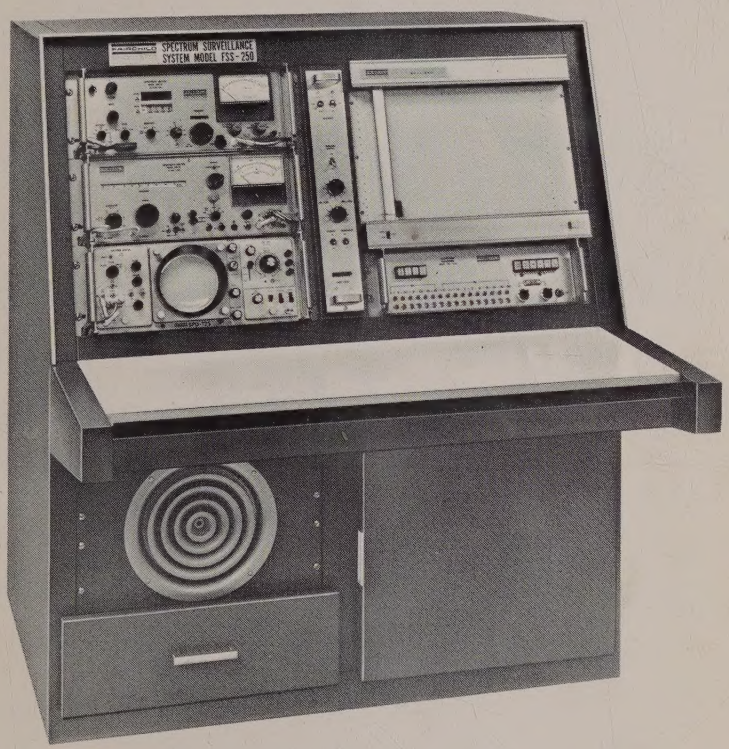
A. M. QUAAS

INSTRUCTION MANUAL

SPECTRUM SURVEILLANCE SYSTEM



MODEL FSS-250/250D

FAIRCHILD
ELECTRO-METRICS
CORPORATION
A SUBSIDIARY OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

AMSTERDAM, NEW YORK

INSTRUCTION MANUAL

SPECTRUM SURVEILLANCE SYSTEM MODEL FSS-250/250D

FAIRCHILD
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TABLE OF CONTENTS

		Page
SECTION I	INTRODUCTION	1-1
1.1	THE MANUAL	1-1
1.2	THE FSS-250/250D	1-1
1.3	MODEL FSS-250 ELECTRICAL SPECIFICATIONS	1-1
1.3.1	Spectrum Coverage	1-1
1.3.2	Readout Modes	1-1
1.3.3	Spectrum Scan Time	1-1
1.3.4	Scanning Modes	1-1
1.3.5	Frequency Accuracy	1-2
1.3.6	Sensitivity	1-2
1.3.7	Amplitude Accuracy	1-2
1.3.8	Calibrators	1-2
1.3.9	Dynamic Range	1-2
1.3.10	Measurement Range	1-3
1.3.11	Detector Functions	1-3
1.3.12	Temperature Range	1-3
1.3.13	Power Requirements	1-3
1.3.14	Accessories, Convenience Items Supplied	1-3
1.3.15	Options	1-3
1.4	MODEL FSS-250D ELECTRICAL SPECIFICATIONS	1-3
1.5	MECHANICAL SPECIFICATIONS	1-3
SECTION II	THEORY OF OPERATION	2-1
2.1	GENERAL	2-1
2.2	SYSTEM COMPONENTS	2-1
2.2.1	EMC-10	2-1
2.2.2	EMC-25R	2-1
2.2.3	SPD-125	2-1
2.2.4	EXY-125A	2-2
2.2.5	EXY-250	2-2
2.2.6	ESC-125A	2-2
2.2.7	Control Center	2-2
2.2.8	Meter Panel	2-3
2.2.9	Speaker	2-3
2.2.10	Options	2-3
2.2.11	Rear Connections	2-4
2.2.12	Power Frequency Rejection Filter	2-4
2.2.13	SU-125	2-4
2.3	OPERATION	2-4
2.3.1	Power System	2-5
2.3.2	Input Switching	2-5
2.3.3	X-Y Plotting	2-5
2.3.4	Quick-Look Mode	2-6
2.3.5	Manual Operation	2-6
2.3.6	Audio Amplifier	2-6
2.4	ADDITION OF OPTIONS	2-7
SECTION III	OPERATING INSTRUCTIONS	3-1
3.1	GENERAL	3-1
3.2	UNPACKING	3-1
3.3	ELECTRONIC SHIPPING DAMAGE	3-1
3.4	POWER REQUIREMENTS	3-1
3.5	INSTALLATION	3-1
3.6	FRONT PANEL CONTROLS	3-1
3.6.2	SPD DET/NORM Switch (Pen 1 Switch in FSS-250D)	3-1
3.6.3	PEN 1 Switch	3-1
3.6.4	PEN 2 Switch	3-1
3.6.5	SPD-ESC	3-1
3.6.6	CAL Level Controls	3-2
3.6.7	Speaker and De-Emphasis	3-2
3.6.8	BAND Counter	3-2
3.7	GENERAL OPERATING CONSIDERATIONS	3-2
3.8	PRE-OPERATIONAL CALIBRATION AND ALIGNMENT	3-3
3.8.2	Chart Paper Calibration	3-3
3.9	SPECIFIC OPERATING PROCEDURES	3-6
3.9.1	System Power	3-6
3.9.2	Inputs	3-6
3.9.3	X-Y Plotting	3-6
3.9.4	Quick-Look Mode	3-8
3.9.5	Manual Operation	3-9
3.9.6	Time Domain Display	3-9
SECTION IV	SERVICE AND MAINTENANCE	4-1
4.1	GENERAL	4-1
4.2	EQUIPMENT ACCESS	4-1
4.2.1	Removal of Instruments for Alignment	4-1
4.2.2	Procedure for Removing Instruments	4-1
4.3	PERIODIC SERVICE/ CALIBRATION	4-2
4.3.1	2000 Count Calibration	4-2
4.3.2	10,000 Count Calibration	4-2
4.3.3	Order of Calibration	4-2

		Page
4.4	TROUBLESHOOTING	4-3
4.5	REPLACEABLE ASSEMBLIES	4-3
4.6	PEN 2 ALIGNMENT	4-3
4.7	TUNING OF REJECTION FILTER	4-4
SECTION V	OPERATION OF OPTIONS	5-1
5.1	GENERAL	5-1
5.2	AUXILIARY PROGRAMMING	5-1
5.2.1	PSA-125	5-1
5.3	INPUT SWITCHING	5-1
SECTION VI	REFERENCE DATA	6-1
6.1	GENERAL	6-1

LIST OF TABLES

Table 1-1	Sensitivity	1-2
Table 3-1	Control Settings - Permanent Copy Mode (X-Y Plot)	3-4
Table 3-2	Control Settings - Quick-Look Mode	3-5
Table 4-1	Power Supply Meter Readings	4-3
Table 5-1	Programmable Functions	5-5

LIST OF ILLUSTRATIONS

Figure 1.1	Outline Drawing	1-4
Figure 2.1	Spectrum Surveillance System, FSS-250	2-2
Figure 2.2	Control Center, Functional Diagram	2-3
Figure 2.3	Switching Unit, SU-125 Connections	2-4
Figure 3.1	Spectrum Surveillance System, Component Location	3-2
Figure 3.2	FSS-250, Front Panel Controls	3-3
Figure 3.3	Normal Programming of SU-125	3-7
Figure 4.1	Location of Tuning Filter Adjustments	4-4
Figure 5.1	Control and Terminal Location	5-3
Figure 6.1	Control Center, FSS-250, Schematic Diagram	6-3
Figure 6.2	Control Center, FSS-250D, Schematic Diagram	6-5
Figure 6.3	Meter Panel, Schematic Diagram	6-7
Figure 6.4	FSS-250, System Cabling Diagram	6-9
Figure 6.5	FSS-250D, System Cabling Diagram	6-11
Figure 6.6	FSS-250, R.F. Cabling Diagram	6-13
Figure 6.7	FSS-250D, R.F. Cabling Diagram	6-15
Figure 6.8	Attenuator, PSA-125, Schematic Diagram	6-17

SECTION I
INTRODUCTION

1.1 THE MANUAL

This manual includes all relevant information for the successful operation, maintenance and repair of the Spectrum Surveillance Systems, Models FSS-250 and the FSS-250D.

1.2 THE FSS-250/250D

Fairchild Electro-Metrics Spectrum Surveillance Systems, Model FSS-250/250D, has been designed to automate the analysis of Radio Frequency Interference. Two programmable receivers, the EMC-10 and the EMC-25R, are used to encompass a frequency range from 20 Hz to 1.0 GHz. The EMC-10 and the EMC-25R Interference Analyzers are sensitive, well-shielded superheterodyne receivers with accurate amplitude and frequency calibration. The EMC-10 and the EMC-25R are designed such that all significant parameters can be remotely programmed by contact closure or by voltage and resistance variation. This feature has the advantage that no special modifications to these receivers are required to incorporate them as a part of the system. The system further incorporates Fairchild Electro-Scan Programmer Model ESC-125A, X-Y Plotter Model EXY-125A (FSS-250) or EXY-250 (FSS-250D), and Spectrum Display Module SPD-125. With this system it is possible to cover any portion, or all of the frequency range of 20 Hz to 1 GHz, and plot the spectrum profile of the selected range on the X-Y plotter, or by choice, analyze a selected portion of the spectrum on the Spectrum Display Module.

Instructions for operation of the complete system are included in Section III of this manual. Independent operation of the various components is covered in their respective manuals.

1.3 MODEL FSS-250 ELECTRICAL SPECIFICATIONS

1.3.1 SPECTRUM COVERAGE. 20 Hz - 1 GHz in 16 bands.

1.3.2 READOUT MODES

1.3.2.1 QUICK-LOOK MODE. Selectable instantaneous CRT display of any of the 15 bands between 14 KHz and 1 GHz. Any portion of a band from greater than a full octave or down to 0.1% of the band can be displayed on a 10-cm width screen. A time domain display of 20 sec/cm to 0.1 usec/cm is also available. Either linear or logarithmic frequency and time domain displays can be presented on the 6.3-cm calibrated graticule.

1.3.2.2 PERMANENT COPY MODE. An X-Y plotter with non-clog vacuum hold-down system accepts either 8-1/2 inch by 11 inch or 11 inch by 17 inch chart paper. Single bands or any portion of a single band can be automatically plotted on the full width of the paper.

Any or all multiple bands are displayed in a four row by four column matrix resulting in 47 lineal inches of frequency display. Time domain display from 10 seconds to 200 seconds duration with $\pm 3\%$ linearity permits single frequency transient tests.

1.3.3 SPECTRUM SCAN TIME

1.3.3.1 QUICK-LOOK MODE. CRT presentation of all bands between 14 KHz and 1 GHz.

1.3.3.2 PERMANENT COPY MODE

a) Single Band - infinitely adjustable 40 sec/scan to 1 hr/scan.
b) Multiple Band - infinitely adjustable 10 sec/band to 15 min/band.

1.3.4 SCANNING MODES. Single-Band, Multi-Band, Sector - Automatic selection of chart size, scan speed and sector selection depending on number of bands chosen.

1.3.4.1 SINGLE-SCAN. All bands selected are sequentially scanned with the program halted and reset automatically at the end of the last selected band.

1.3.4.2 MULTI-SCAN. All bands selected are sequentially and continuously scanned until the program is manually interrupted.

1.3.4.3 CALIBRATE. Similar to SINGLE-SCAN but additionally the built-in impulse calibrator is placed in operation and the remote Switching Unit SU-125 is actuated to properly route the calibrating signal.

1.3.4.4 MANUAL. Permits manual frequency control of either the EMC-10 or EMC-25R through their tuning controls. A time domain display can be obtained on the SPD-125 and recorded on the EXY-125A.

1.3.4.5 PLOTTER CALIBRATE. Used to normalize the plotter for drift and for variations in paper size and printing.

1.3.5 FREQUENCY ACCURACY. As specified for individual instruments. Accuracies of ±3% or better can be achieved with EMC chart paper.

1.3.6 SENSITIVITY (See Table 1-1)

a) All sensitivity measurements should be made at the rear panel connector plate.
b) Wideband sensitivity measurements should be made with the EMC-10 BW Selector at 250 Hz and the EMC-25R BW Selector at WB. Both detector function switches should be set to PEAK. Signal source is the impulse generator.
c) Narrowband sensitivity measurements are made with the EMC-10 BW Selector at 5 Hz and the EMC-25R BW Selector at NB. Both detector function switches should be set to CARR. Signal source is a CW generator.
d) All measurements of sensitivity are tangential and are guaranteed worst case conditions. They are indications of the amount of signal required to raise the meter reading 3 DB above the terminated internal noise level.

1.3.7 AMPLITUDE ACCURACY. Within 2 DB (CW or single-shot impulse).

1.3.8 CALIBRATORS

a) 20 Hz - 16 KHz: Fail-safe CW.
b) 14 KHz - 1 GHz: Impulse Generator -11 to +80 DB/uV/MHz (repetition rate of 54 Hz is non-synchronous with power line).

1.3.9 DYNAMIC RANGE

a) Broadband: 40 DB to 70 DB, depending on band in use.
b) Narrowband: 60 DB to 90 DB, depending on band in use.

TABLE 1-1

SENSITIVITY
(See Paragraph 1.3.6 for Definitions)

BAND	FREQUENCY RANGE	3 DB BW (Selectable)	SENSITIVITY NB(uV)	SENSITIVITY WB(DB/uV/MHz)
0	20 Hz - 14 KHz	5-50-250 Hz	.005*	65*
1	14 KHz - 28.5 KHz	0.5-4 KHz	.07	40
2	28.5-59 KHz	0.5-4 KHz	.07	40
3	59-120 KHz	0.5-4 KHz	.07	40
4	120-240 KHz	0.5-4 KHz	.07	40
5	240-480 KHz	0.5-4 KHz	.07	39
6	0.48-1.05 MHz	0.5-5 KHz	.07	38
7	1.05-2.3 MHz	0.5-5 KHz	.07	38
8	2.3-5.0 MHz	5-50 KHz	.125	25
9	5-11 MHz	5-50 KHz	.125	25
10	11-25 MHz	5-50 KHz	.14	25
11	24-49 MHz	50-500 KHz	.9	20
12	49-98 MHz	50-500 KHz	1.1	20
13	98-210 MHz	50-500 KHz	1.4	20
14	210-490 MHz	50-500 KHz	1.6	26
15	490-1000 MHz	50-500 KHz	4.0	34

*Above 400 Hz only. See detailed EMC-10 specifications.

1.3.10 MEASUREMENT RANGE. As specified for individual instruments.

1.3.11 DETECTOR FUNCTIONS

a) 20 Hz - 16 KHz: Carrier, RMS, Quasi-Peak, +and - Peak (Scan Detector), Slideback.
b) 14 KHz - 1 GHz: Carrier, Quasi-Peak, Peak (Scan Detector), AM and FM Modulation, Metered Slideback.

All detector functions can be used manually or may be plotted.

1.3.12 TEMPERATURE RANGE

a) Operating: 0°C to +50°C
b) Storage: -40°C to +65°C

1.3.13 POWER REQUIREMENTS. 105-130 or 210-260 volts AC, 45-65 Hz, 425 VA (may be operated up to 450 Hz without plotter).

1.3.14 ACCESSORIES, CONVENIENCE ITEMS SUPPLIED

a) Four-watt high quality audio amplifier and eight-inch speaker.
b) Metering panel for checking system voltages.
c) Band counter for recording system usage.
d) Remote Input Switching Unit, Model SU-125, for switching up to seven input transducers.
e) All-welded cabinet with built-in desk and locking casters (see Figure 1.1).

1.3.15 OPTIONS. Suitable tiepoints and voltages are provided for the following optional features.

a) Programmable Step Attenuator, Model PSA-125, with steps of 0, 20, 40, 60, 80 DB and a 50-ohm termination.
b) Inclusion of multiple Remote Input Switching Units (Model SU-125).
c) Programming on a band-by-band basis of:
1. Scan speed
2. Bandwidth
3. Impulse generator level
4. Vernier gain
d) Instantaneous call-up of any number of frequencies.

1.4 MODEL FSS-250D ELECTRICAL SPECIFICATIONS

1.4.1 All specifications as in paragraph 1.3 except that a Dual Pen X-Y-Y' plotter Model EXY-250 is substituted for a Single Pen Plotter Model EXY-125A and additional electronics are included to permit simultaneous plotting of both peak and average values of input signals in the frequency range of 14 KHz to 1 GHz.

1.5 MECHANICAL SPECIFICATIONS

1.5.1 Dimensions of the console are shown in Figure 1.1.

1.5.2 Weight is approximately 450 pounds.

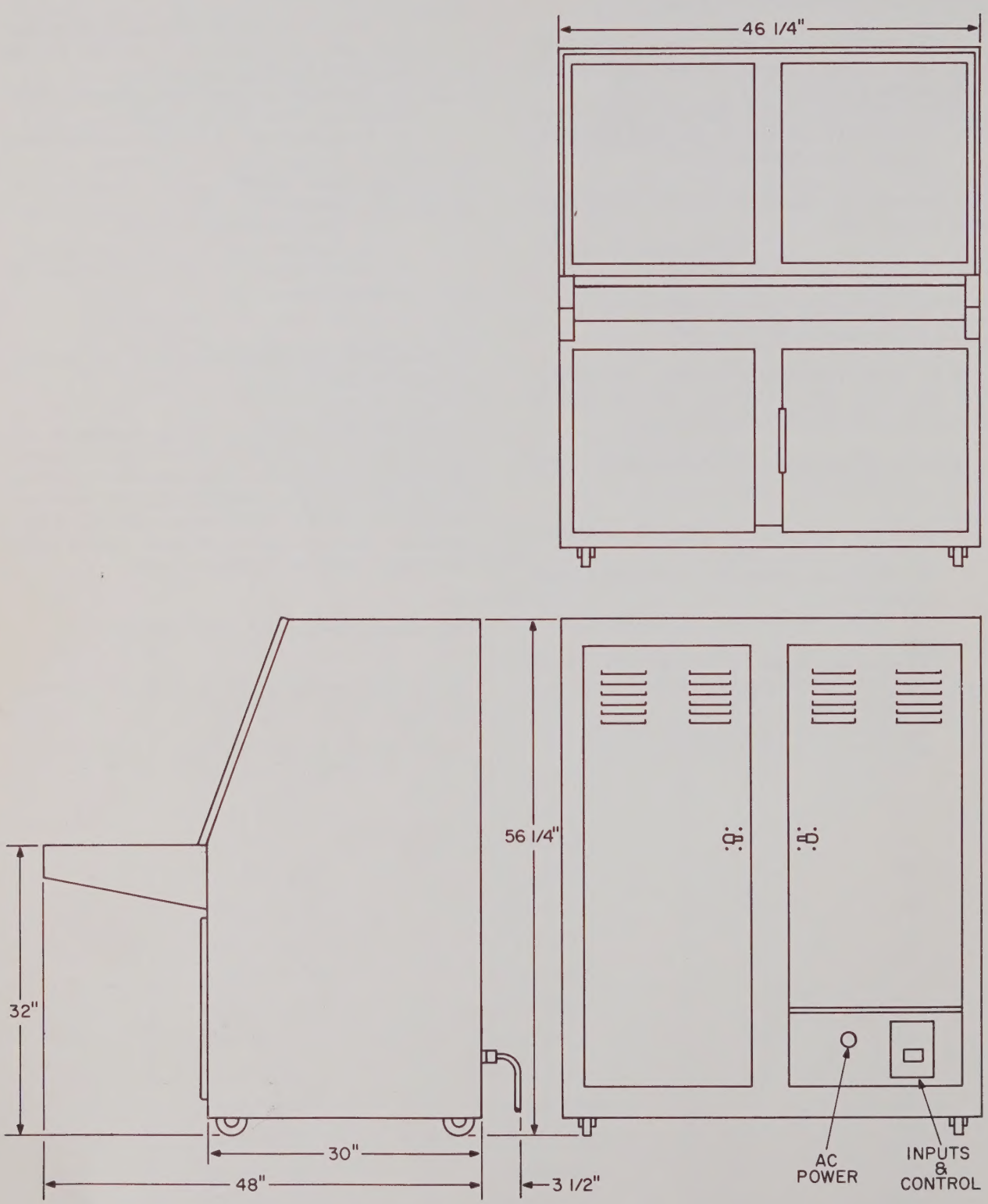


Figure 1.1 Outline Drawing

SECTION II
THEORY OF OPERATION

2.1 GENERAL

Frequency Surveillance System, Model FSS-250/250D covers the frequency range of 20 Hz to 1 GHz and provides a multiplicity of operating and display modes. Analysis of signals in this frequency range may be performed manually or automatically and displayed on the X-Y Plotter included in the system. An instantaneous visual display can also be obtained over the frequency range of 14 KHz to 1 GHz. The FSS-250 is composed of the main console, Switching Unit, and interconnecting cables. The console contains two receivers, a visual display, an X-Y Plotter, and auxiliary devices. These components are used individually or in combination to produce the operating modes discussed further in this book.

2.2 SYSTEM COMPONENTS (Figure 2.1)

The following components are contained in all standard Model FSS-250, Frequency Surveillance Systems. Their individual functions are discussed in this paragraph. Component operation as a portion of the system is discussed in paragraph 2.3. A more thorough discussion of each one of these components will be found in the individual instruction manuals accompanying the system.

2.2.1 EMC-10. The Model EMC-10 Interference Analyzer is used in the system to cover the frequency range of 20 Hz to 16 KHz. This receiver has a built-in CW calibrator and is remotely tunable through the application of a tuning voltage to the remote control connector. It has a wide selection of input impedances and selectable input low pass filters. A wideband channel covering the entire frequency range of the instrument and a narrowband channel containing three selectable IF bandwidths are included. Several outputs are available; however only the audio output and the DC analog of the detector output are used in the FSS-250 system. The extremely low sweep rates required by the narrow IF bandwidths prevent the use of the oscilloscope for spectrum display. Amplitude versus frequency output of the EMC-10, however, can be recorded on the X-Y Plotter, Model EXY-125A.

2.2.2 EMC-25R. The Model EMC-25R, Interference Analyzer, covers the frequency range from 14 KHz to 1 GHz. It has many programmable functions which may be used in the FSS-250 system. These functions include tuning across each of the fifteen octave bands by means of a 0 to +1.35-volt input, band switching, detector charge dump, vernier gain control, impulse generator operation, impulse generator level, bandwidth, and remote AFC control. Outputs used in the system are DC detector analog, audio, IF, band coding, and AM video. The EMC-25R can be used manually with the output read on a self-contained meter or in conjunction with the SPD-125 Spectrum Display Module or ESC-125A Programmer. The built-in impulse generator calibrator is used for system amplitude calibration over the frequency range of the EMC-25R.

2.2.3 SPD-125. Model SPD-125 Spectrum Display Module provides amplitude versus frequency or amplitude versus time display of the output of the EMC-25R. The SPD-125 has a five-inch CRT with a P31 phosphor and uses plug-in vertical and time base modules. For an amplitude versus frequency display (SPECTRUM mode setting), the time base module furnishes the tuning signal for the EMC-25R. The mode selector switch, located on the vertical plug-in, determines whether the display is an entire preset band of the EMC-25R (SPECTRUM), a 10% to 0.1% portion of the band (SIGNATURE), or a fixed frequency (VIDEO) for video information. Time base may be synchronized either internally, externally or with the line frequency. The vertical plug-in, Model PP-125, may by driven by either the AM VIDEO output of the EMC-25R to provide a logarithmic display or, by the POST IF output of the EMC-25R, to provide a linear display. For linear display three IF amplifiers are included in the PP-125. These correspond to the IF output frequencies of the EMC-25R and are automatically switched, according to the band logic signals supplied by the EMC-25R through the ESC-125A Programmer. Detailed information concerning the SPD-125 may be found in the CSR-200 instruction manual. The CSR-200 is a combination of an SPD-125 and an EMC-25.

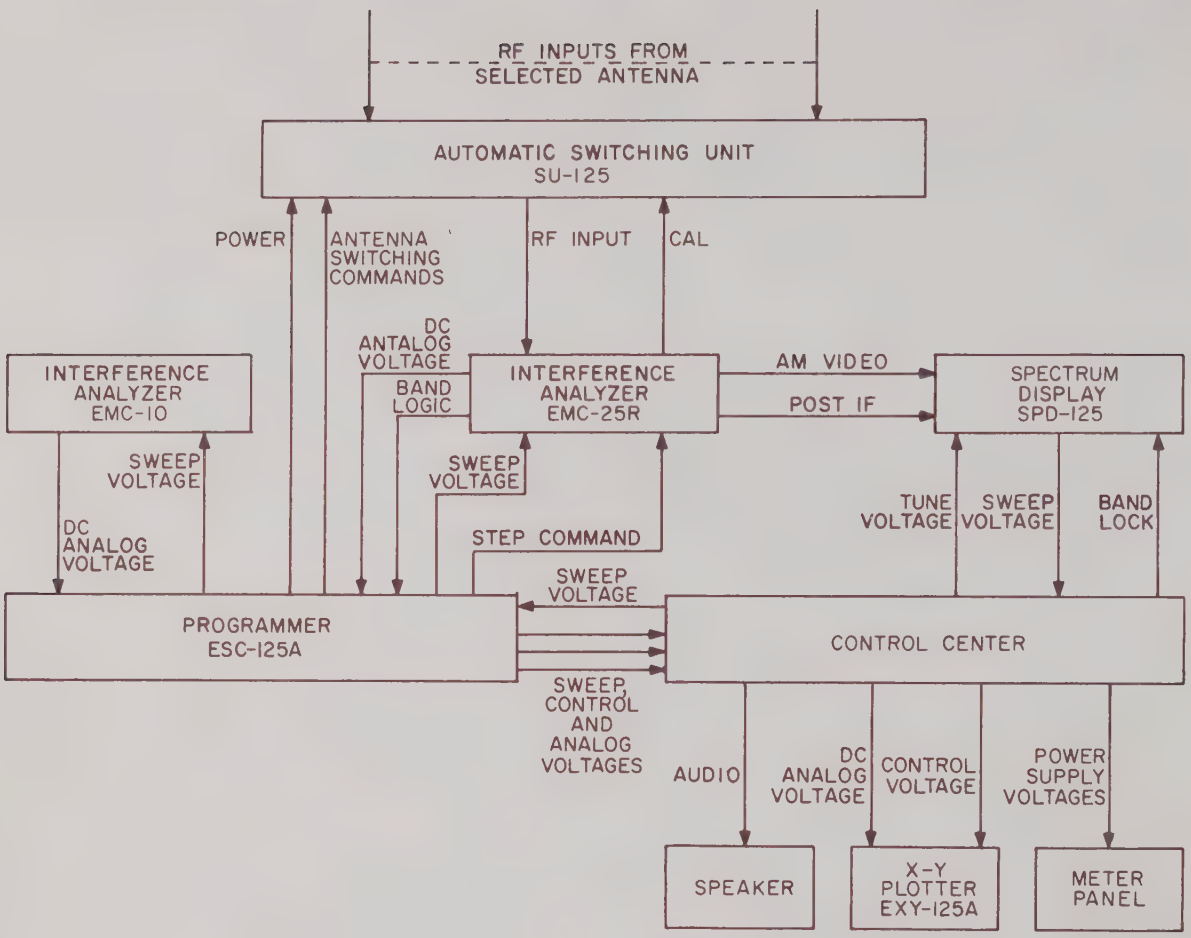


Figure 2.1 Spectrum Surveillance System, FSS-250

2.2.4 EXY-125A. A Model EXY-125A Plotter is used in standard FSS-250 systems. This plotter has a nominal 100-kilohm input impedance on both channels and nominal 1.5-volts full scale sensitivity in both axis. A barrier strip in the rear provides inputs for both X and Y channels as well as a remote pen drop function. X and Y GAIN and ZERO controls are located beneath the lower cover on the plotter front panel. The vacuum platen is designed to be used with either 8-1/2 inch by 11 inch or 11 inch by 17 inch chart paper.

2.2.5 EXY-250. FSS-250D systems use the EXY-250 X-Y-Y' plotter. All three inputs to this plotter have a nominal 100-kilohm input impedance and a nominal 1.5-volt full scale sensitivity. A barrier strip at the rear of the plotter provides for the three floating inputs as well as two separate pen drop functions. The vacuum platen is designed to take either 8-1/2 inch by 11 inch or 11 inch by 17 inch chart paper.

2.2.6 ESC-125A. The Programmer, Model ESC-125A, provides all control functions when the EXY-125A or EXY-250 Plotter is used for amplitude versus frequency readout and always selects the band in use. It also provides control signals to operate the Switching Unit, SU-125, and provides logic signals and power for the Control Center and various optional accessories. It also provides correct inputs for the X-Y plotter, attenuating and offsetting the signals as required.

2.2.7 CONTROL CENTER (Figure 2.2). The audio amplifier, band counter, pen and impulse generator controls are located in the Control Center. The BAND COUNT circuit stretches the pulse, derived from the band advance circuit within the ESC-125A, to a length and power level sufficient to operate the electro-mechanical band counter. The band counter therefore advances one step each time the band advance command is received. The BAND COUNT cir-

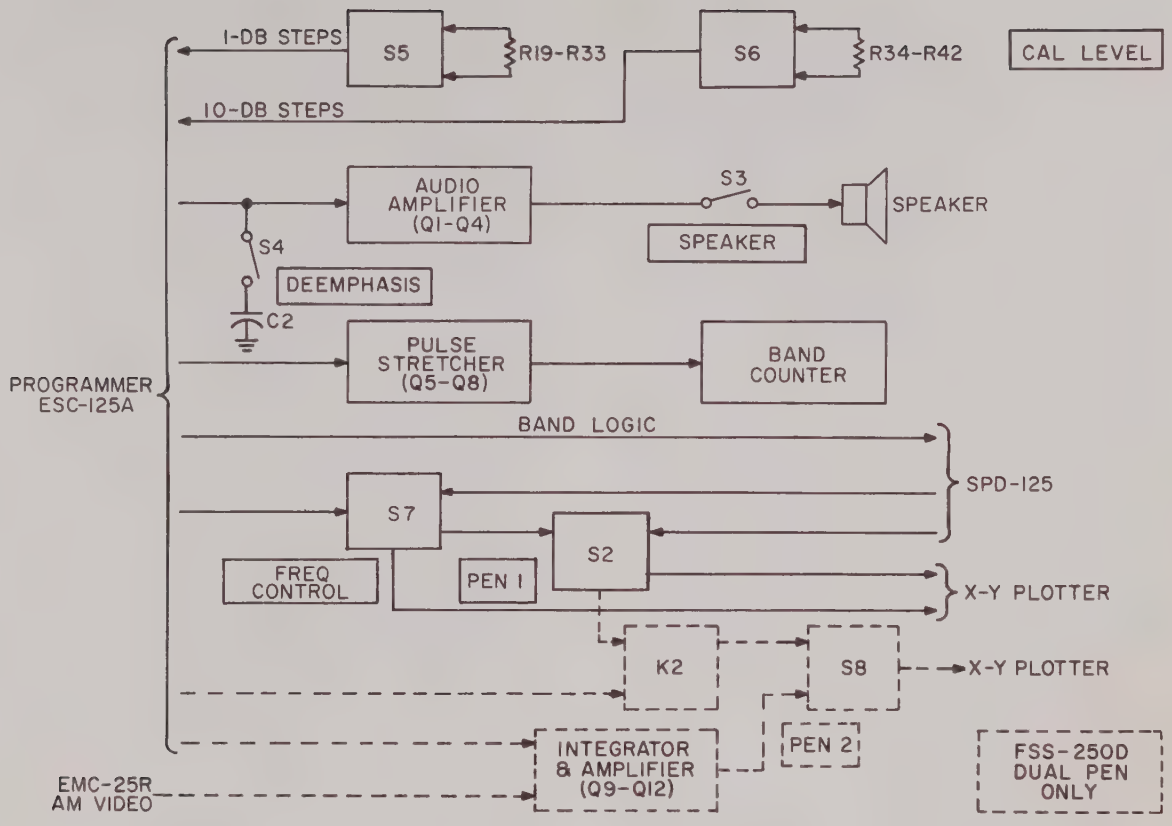


Figure 2.2 Control Center, Functional Diagram

cuit consists of transistors Q5-Q8. The Audio Amplifier consisting of transistors Q1-Q4 is capable of delivering four watts continuous sine wave power into an eight-ohm load. DC power is derived from the +27 volt supply within the programmer. The audio input is derived from two series padding resistors R1 and R2 connected to the audio outputs of the EMC-10 and EMC-25R. The AUDIO controls on both receivers, therefore, control the audio output amplitude. The impulse generator level switches, S5-S6, form a voltage divider with resistors R19-R33 and R34-R42, respectively. They are supplied with regulated +300 volts from the ESC-125A power supply. In FSS-250D dual-pen systems, a double-pole relay is located in the Control Center to allow both pens to be dropped simultaneously by the single pole relay located in the Programmer. An integrating circuit and an operational amplifier Q12 are used to provide average signal to drive the Y' pen. Q9 and Q10 are used to change the gain of Q12 as determined by single or multiband modes. Numerous barrier strips located within the Control Center provide the programming functions and operating power for all options.

2.2.8 METER PANEL. This panel is located in the right-hand section beneath the desk. A zero-center meter and two jacks for external meters are connected through a rotary switch to the Control Center where power supply voltages in the system are connected. A three-position toggle switch determines the meter range by insert resistors in series with the meter. Right-hand deflection on the meter indicates a positive voltage and left-hand deflection indicates a negative voltage.

2.2.9 SPEAKER. An eight-inch high quality speaker is located beneath the desk in the left-hand panel. This speaker is connected to the audio amplifier in the Control Center and to the external speaker jack on the rear panel.

2.2.10 OPTIONS. Power, control and band information connections are located on the barrier strips contained in the Control Center. Programming options are usually located in the panel space on the right-hand side below the desk. Options such as the PSA-125 Programmable Step Attenuator are accompanied by instruction sheets and schematics.

2.2.11 REAR CONNECTIONS. The AC power connection is a 15-amp three-prong "twist lock" receptacle at the rear of the console. Systems are normally wired for 115 volt 60 Hz operation; for 230-volt operation follow the instructions in Section III. A connector panel in the rear of the console provides the following connections:

a) Separate RF and Calibration TNC connectors for the 20 Hz to 16 KHz and 14 KHz to 1 GHz ranges.
b) A 34-pin connector which provides control voltages to the SU-125.
c) A 15-pin connector which provides proper voltages for operation of a PEF-10 Electrostatic Field Probe or PCA-10 Current Probe Amplifier.
d) A quarter-inch phone jack for connection to an external four to sixteen-ohm speaker (the internal speaker is disconnected when an external speaker is used).

2.2.12 POWER FREQUENCY REJECTION FILTER. This filter is located on the EMC-25R control cable just to the right of the EMC-25R behind the cabinet front panel. The filter provides a deep notch at twice the AC power supply frequency while passing DC and low frequency signals. It is used to minimize ripple on the frequency control line which might cause unwanted FM of the EMC-25R local oscillator.

2.2.13 SU-125 (Figure 2.3). An Input Switching Unit, Model SU-125, is provided with each FSS-250. It contains a one-pole, four-position and a one-pole, six-position coaxial relay. One position of each of the coaxial relays is reserved for the CAL function and is actuated when the CAL button of the ESC-125A is depressed. All other positions of the coaxial relays may be programmed by jumpers inserted in a plug board (in the SU-125 case). In this manner any relay may be actuated during any band.

2.3 OPERATION

This section describes the function of each instrument in the various modes of operation.

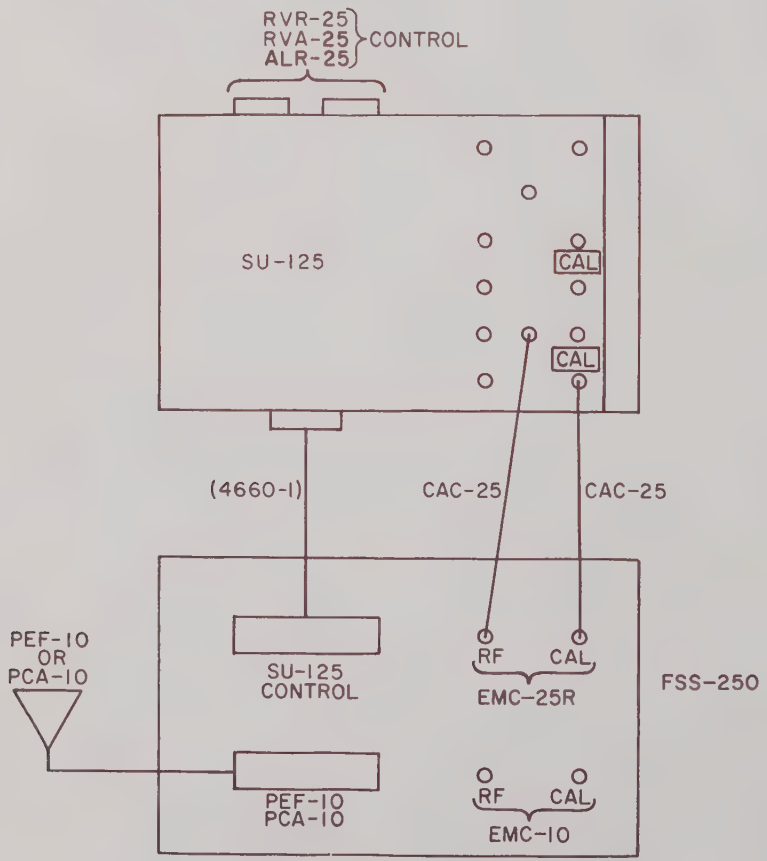


Figure 2.3 Switching Unit SU-125 Connections

Interconnections and the relationship between instruments are also discussed.

2.3.1 POWER SYSTEM. The EMC-10, EMC-25R, SPD-125, EXY-125A and ESC-125A have individual line operated power supplies. The EMC-10 and EMC-25R use internal batteries which are charged when AC power is connected to the system. The EMC-10 and EMC-25R can be removed from the system and battery operated at any time. DC power to operate the Control Center and some accessories is obtained from the ESC-125A Programmer. All AC connections are made to junction boxes in the rear of the cabinet. Normal system operation requires turning on each instrument separately.

2.3.2 INPUT SWITCHING. Signals from pickup devices are switched through the coaxial relays in the SU-125. The +27 volts DC, required to switch the relays, comes through an interconnecting cable to the SU-125 from the connector panel on the rear of the FSS-250, which is provided by the ESC-125A. The programmer band is indicated by one of the signal lines in this cable being grounded. Other wires in this cable carry a ground for calibration mode and +27 volts.

2.3.3 X-Y PLOTTING. In the X-Y plotting mode all bands chosen for either the EMC-10, EMC-25R or both are plotted automatically on chart paper. The program is controlled from the ESC-125A. The EMC-25R tuning voltage from the ESC-125A passes through the Control Center when the SPD-ESC switch is in the ESC position. This gives the ESC-125A frequency control over the EMC-25R. Details of Programmer operation are found in the ESC-125A instruction manual.

2.3.3.1 PLOTTER NORMALIZATION. Due to variations in paper size and chart reproduction it is necessary to adjust the X and Y GAIN and ZERO controls of the X-Y plotter before making a plot. To do this the ◄┼ and ┼► buttons on the Programmer are pressed sequentially placing standard voltages across the input terminals of the X-Y plotter.

2.3.3.2 CALIBRATION. Before making an X-Y plot, all sixteen bands on the chart paper must be calibrated for amplitude and the upper five bands for frequency. The 20-Hz to 16-KHz band is calibrated with the EMC-10 built-in CW calibrator and the SLIDEBACK function. A fixed factor is then applied to the CW calibration to arrive at impulse calibration. In the 14-KHz to 1-GHz range the impulse calibrator in the EMC-25R is used to obtain the calibration curves. The level of these calibration curves is set by the controls on the Control Center. Lines of constant CW calibration can be determined from the calibration curves supplied with the EMC-25R or may be plotted using an external CW source. Frequency calibration marks for the upper five bands are made by operating the ESC-125A in the manual mode and setting the FREQUENCY control of the EMC-25R to each frequency line to be calibrated. The pen is then lowered and the SLIDEBACK control of the EMC-25R adjusted so that a vertical line is drawn on the chart paper. Factors for the pickup devices and cables must also be considered to arrive at the final calibration.

2.3.3.3 PROGRAMMER OPERATION. ESC-125A controls the band in use by comparing the internally generated code, corresponding to the light illuminated on the front panel, with the code generated by EMC-25R BCD band logic switches. If an error exists, the Programmer supplies a step command voltage to the EMC-25R causing its turret to rotate until the codes agree. The EMC-10 band is represented as band 0000 of the EMC-25R. In all automatic modes of operation an internally generated ramp (0 to +1.35 volts) is applied to the EMC-25R, a ramp of approximately 0 to +0.5 volts is applied to the EMC-10 and a variable amplitude ramp is applied to the X input of the plotter. At a voltage slightly above that corresponding to the top of the tuning band, an internal trigger circuit generates the command for the Programmer to advance to its next selected band. This continues until completion of the program. The band code switches of the EMC-25R are supplied with +3.6 volts from the Programmer to operate the Programmer circuit and the SPD-125 to energize the proper IF amplifier. These switches also supply code signals through the Programmer and through the remote cable to the Input Switching Unit to the low frequency antennas to cause them to step to the proper band position. Even when the Programmer is not in control of the frequency of the EMC-10 or EMC-25R, it always controls the band and must be on to activate the antennas and the coaxial relay switching the SU-125 inputs.

2.3.3.4 FSS-250D DUAL PEN. To obtain additional information about the signal it is often desirable to simultaneously plot the average and peak amplitudes of the signal versus frequency. In the Model FSS-250D a dual pen plotter is used to accomplish this function. In this plotter there is a single X input. This input and the various controls to the receivers are described in paragraph 2.3.3.3. In the Y axis, the two pens move on a pair of tracks only one-sixteenth of an inch from each other so that essentially the same point is plotted by each. The Y pen is driven with the detector output of two interference analyzers (modified by the ESC-125A bias

and attenuation circuits). Y' pen is driven by the average signal of the EMC-25R only. If the output of the EMC-10 were averaged, an impractically slow sweep rate would be needed. The average signal for the second pen is derived by integrating the AM VIDEO output of the EMC-25R. The AM VIDEO output signal from the EMC-25R is fed to a high impedance integrator in the Control Center. The time constant of the integrator is approximately 200 msec. The integrated signal then goes to an operational amplifier to drive the X-Y Plotter. At this point the signal is a slowly varying DC level with a peak amplitude of approximately 25 to 50 MV. The gain of the operational amplifier is programmable to a high or low gain mode as determined by the single-band/multi-band command line wired directly to the amplifier. Individual GAIN and ZERO controls for the operational amplifier are located on the Control Center. The output of the operational amplifier is 1.5 volts in the single band mode and 0.37 volts in the multi-band mode at full scale meter deflection. This voltage is then applied directly to the Y' input of the plotter. The PEN 2 switch on the Control Center places the Y' input in parallel with the Y input so that the plotter GAIN and ZERO controls may be adjusted for correct placement of the pens (OFF). When the PEN 2 switch is in the ON position the Y' channel is connected to the operational amplifier output. The PEN 2 switch disables the pen drop function of the Y' pen in the OFF position and enables it in the ON position. The PEN 1 switch on the Control Center enables automatic dropping of the Y pen when in the OFF position. In the ON position PEN 1 switch drops the Y pen of the X-Y Plotter. The pen drop relay in the ESC-125A is a single-pole, single-throw reed relay. As the two pens drop, the pen drop coils of the EXY-250 must be energized independently. A plug-in relay is included in the Control Center and is operated by the single-pole relay within the Programmer to drop the pens.

2.3.4 QUICK-LOOK MODE. When the ESC-SPD switch on the Control Center is in the SPD position, tuning of the EMC-25R is controlled by the SPD-125. The band in which this system operates, as well as the SU-125 and impulse generator operation, is controlled by the ESC-125A Programmer. Band sweep time is limited to the 50 msec/cm scale of the time base of the SPD-125 due to the use of the notch filter referenced in paragraph 2.2.12. The X input of the plotter is now connected to the output of the time base of the SPD-125. The Y input of the plotter is connected through the ESC-125A Programmer to either the EMC-25R or EMC-10 Detector. This allows for time domain display of any signal up to the 200 seconds full scale maximum allowed by the SPD-125 time base when the mode switch is turned to the VIDEO position and the EMC-25R FREQUENCY control is set to the appropriate frequency. Sweep voltage generated by the SPD-125 time base is divided down and offset in such a way that 0 to +1.35 volts is applied to the EMC-25R when the mode switch is in either the SPECTRUM or LOCATOR position. In the SIGNATURE position a DC VOLTAGE, produced by the EMC-25R tuning potentiometer, is superimposed upon a small ramp voltage thus tuning a small band of frequencies centered on the EMC-25R indicated frequency. A detailed description of the SPD-125 can be found in the CSR-200 instruction manual.

2.3.5 MANUAL OPERATION. To manually operate either the EMC-10 or EMC-25R the MAN pushbutton on the ESC-125A Programmer is depressed and the appropriate band selected. The Control Center SPD-ESC switch is normally left in the ESC position and the receiver is tuned to the desired frequency. The manual tuning voltage line from the EMC-10 or EMC-25R is then routed through the Programmer circuits and back to the EMC-10 or EMC-25R to affect their tuning. The X-Y Plotter will follow the setting of the FREQUENCY dials. To operate the EMC-25R manually, it is also permissible to place the Control Center ESC-SPD switch in the SPD position and the SPD mode switch to VIDEO. In either of these manual operation modes all controls of the EMC-10 and EMC-25R can be operated normally, with the exception of the frequency control of the EMC-10 which should never be turned higher than 16 KHz or the EMC-10 will cause the Programmer to trigger into the next highest selected band.

2.3.6 AUDIO AMPLIFIER. A four-watt audio amplifier consisting of transistors Q1-Q4 is included in the Control Center. It is a feedback amplifier with R8 and R43 controlling its gain. There are two paralleled inputs through R1 and R2 from the EMC-10 and EMC-25R respectively. As both the EMC-10 and the EMC-25R AUDIO gain controls are fully operative at all times, only the AUDIO control of the desired receiver should be advanced. The DEEMPHASIS switch (S4) on the Control Center places capacitor C2 in the circuit with R1 and R2 to give a high frequency roll off. This control is used when it is desired to listen to an FM signal having pre-emphasis.

2.4 ADDITION OF OPTIONS

Most options to the FSS-250 system are for obtaining automatic functions on a band-by-band basis. Only one of sixteen band lines available at TB3 and TB4 in the Control Center is in its high state at a time. This line is then used in the option chassis to close a contact, change a resistance, or apply a voltage to an appropriate function command line also located on one of the barrier strips in the Control Center. Table 5-1 details those functions appearing on the barrier strips. Appropriate operating voltages for optional equipment can be derived at the barrier strip.

SECTION III
OPERATING INSTRUCTIONS

3.1 GENERAL

This section provides instructions for operation of Models FSS-250 and FSS-250D and for operation of the Switching Unit, SU-125, an accessory item required for most uses of the system. These instructions also include pre-operational calibration.

3.2 UNPACKING

3.2.1 Remove the equipment carefully from the shipping cartons and examine thoroughly for shipping damage. If there is any damage, replace the equipment in the shipping cartons and immediately inform the manufacturer and the carrier of the nature of the damage, the serial number of the equipment, the delivery date, and the invoice number.

3.2.2 Check contents of the cartons against shipping notice to be sure that all components and accessory items are present. (Some items are shipped in the drawer of the console.) Notify the manufacturer immediately of any missing items.

3.3 ELECTRONIC SHIPPING DAMAGE

3.3.1 Before leaving the factory, all equipment is subjected to a complete operational check. However, it is possible that electronic damage may have occurred in transit. It is desirable, therefore, to check the operation of the equipment as soon as possible after unpacking.

To do so, operate the system as described in paragraph 3.9. If the system does not meet the specifications in Section I using the referenced procedures, align the system according to procedures in Section IV.

3.4 POWER REQUIREMENTS

3.4.1 Unless otherwise specified, the FSS-250 is normally wired for operation on a 105 to 130-volt, 45-65 Hz line. 210 to 260-volt operation may be obtained by readjusting each instrument of the system as outlined in the corresponding instruction manual. A notch filter, A1FL1, is normally adjusted to the nominal 60-Hz second harmonic; it should be reset as described in paragraph 4.7 if 50-Hz operation is required.

3.5 INSTALLATION

3.5.1 Figure 3.1 illustrates the location of each component in the Spectrum Surveillance System, FSS-250/FSS-250D. These systems are normally shipped assembled. Installation generally consists of mounting the Switching Unit, SU-125, and connecting all RF control and power cables. Connect the Power Cable PCD-125 to the power receptacle in the rear of the console. The Switching Unit Control Cable #4660-1 is connected to the SU-125 CONTROL connector located on the Input/Output plate at the rear of the console. The front casters can be locked by tilting the locking plates.

3.6 FRONT PANEL CONTROLS

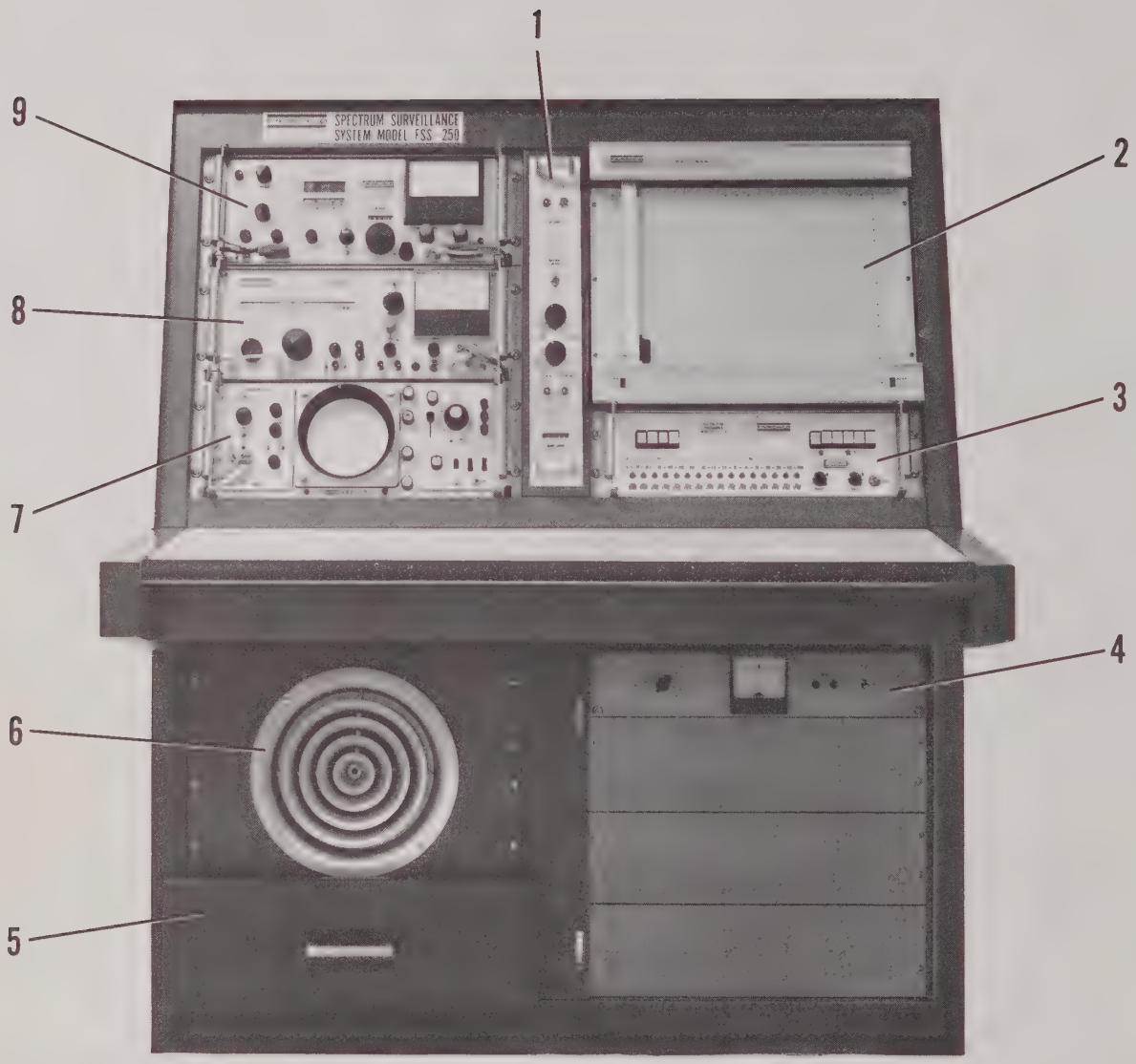
3.6.1 Figure 3.2 shows the upper part of the FSS-250 with front panel indication of each control on the Control Center. Reference to appropriate manuals will show correct designation for front panel controls located on other components of the system.

3.6.2 SPD DET/NORM SWITCH (PEN 1 SWITCH IN FSS-250D). The SPD DET/NORM switch determines whether the EMC-25R detector or SPD-125 detector is used for X-Y plotting (FSS-250 single-pen systems only).

3.6.3 PEN 1 SWITCH. Used to manually drop PEN 1 of the EXY-250 for checking graph paper alignment and operation in the time domain mode (FSS-250D only).

3.6.4 PEN 2 SWITCH. In the OFF position PEN 2 of the EXY-250 in FSS-250D is raised and the pen 1 and 2 deflection circuits paralleled so that the EXY-250 Y' ZERO and Y' GAIN controls can be set. The ON position is used for automatic simultaneous peak and average plotting.

3.6.5 SPD-ESC. The SPD-ESC Frequency Control switch determines whether the ESC-125A or the SPD-125 has tuning control of the FSS-250.



1. Control Center
2. X-Y Plotter, EXY-125A
3. Programmer, ESC-125A
4. Meter Panel
5. Drawer
6. Speaker
7. Spectrum Display Module, SPD-125
8. Interference Analyzer, EMC-25R
9. Interference Analyzer, EMC-10

Figure 3.1 Spectrum Surveillance System, Component Location

3.6.6 CAL LEVEL CONTROLS. The CAL LEVEL controls determine the output of the EMC-25R impulse generator when it is actuated.

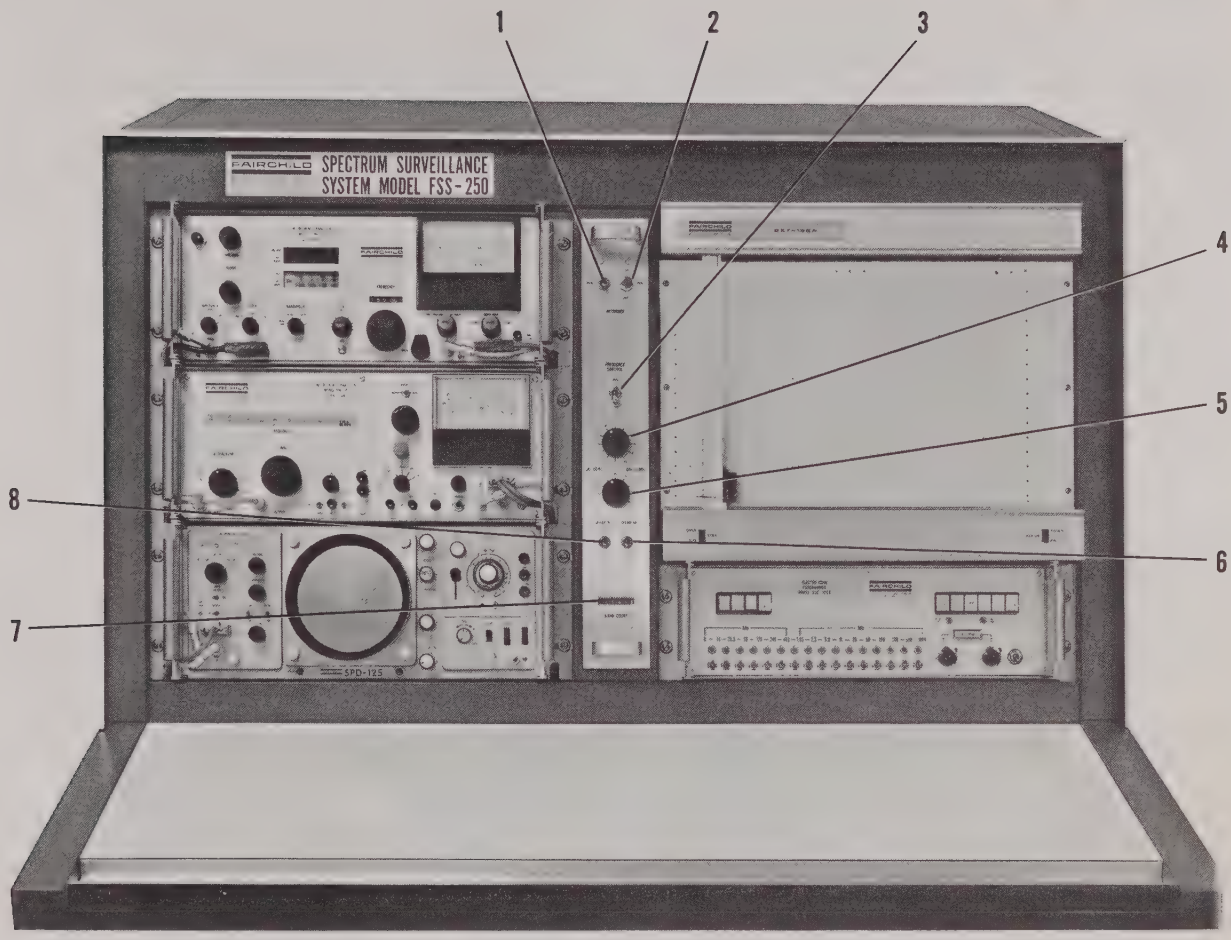
3.6.7 SPEAKER AND DE-EMPHASIS. Turns speaker on and off. Inserts a DE-EMPHASIS network in the audio power amplifier.

3.6.8 BAND COUNTER. The BAND counter provides a visual indication of the cumulative number of bands scanned by the Programmer.

3.7 GENERAL OPERATING CONSIDERATIONS

3.7.1 Successful use of the FSS-250 depends upon proper connection and programming, and proper preparation of chart paper. Instructions for operation in the most common modes are given in the succeeding sections and in Tables 3-1 and 3-2.

A new master chart must be made each time the system is realigned or moved. A check of



1. PEN 1 Switch (FSS-250D)
   SPD DET/NORM Switch (FSS-250)
2. Available for PEN 2 for EXY-250 (FSS-250D)
3. Frequency Control (SW-2)
4. CAL Level (SW-5)
5. CAL Level (SW-6)
6. DE-EMPHASIS (SW-4)
7. Band Counter
8. Speaker ON-OFF (SW-3)

Figure 3.2 FSS-250 Front Panel Controls

the master chart should be made at least once each day. The special chart paper required can either be purchased from Electro-Metrics Corporation or can be reproduced from the masters supplied.

Before initiating a scan it is important to check all control settings and the programming of all options. The versatility of this equipment precludes the listing of all possible operating modes. The instruction manuals for the individual instruments provide more detail on specialized functions.

3.8 PRE-OPERATIONAL CALIBRATION AND ALIGNMENT

3.8.1 It is necessary to realign the system only if a new Analyzer, Programmer or Spectrum Display Module is used, or improper operation is indicated. A complete system as shipped from the factory has had a complete alignment performed. See Section IV for alignment procedures.

3.8.2 CHART PAPER CALIBRATION. Multiband chart paper used with the system must be

TABLE 3-1

CONTROL SETTINGS - PERMANENT COPY MODE (X-Y PLOT)

Control	Setting
EMC-10	
POWER	ON
IMPEDANCE	As Required
FILTER	20 KHz
BANDWIDTH	50 Hz
ATTENUATOR	As Required
TUNING DIAL	<16 KHz
FUNCTION SWITCH	IF VIDEO
DETECTOR	+ PEAK
AUDIO	CCW
BAT. TEST	NA
ΔF	NA
EMC-25R	
ATTENUATOR	As Required
TUNING DIAL AND FINE TUNE	NA
AFC SWITCH	MAN
SWEEP BUTTON	NA
TUNING AID	OFF
DUMP	As Required
THRESHOLD	NA
DETECTOR	PEAK
CAL	As Required
BANDWIDTH	WIDE
SHUNT	NA
SERIES	NA
BAT. TEST	NA
AUDIO	CCW
BAND SWITCH	NA
POWER	ON

Control	Setting
SPD-125	
ALL SWITCHES	NA
CONTROL CENTER	
PEN (1)	NORM
PEN (2)	ON
FREQUENCY CONTROL	ESC
CAL LEVEL SWITCHES	NA
SPEAKER	OFF
DEEMPHASIS	OFF
EXY-125A (EXY-250)	
POWER	OPER (ON)
PEN LIFT	RMTE
ESC-125A	
POWER	ON
OPERATING SWITCHES	START
MODE SWITCHES	SINGLE SCAN
BAND SWITCHES	As Required
SECTOR CONTROLS	As Required
METER PANEL	
SELECTOR SWITCH	NA
RANGE SWITCH	OFF

TABLE 3-2

CONTROL SETTINGS - QUICK-LOOK MODE

Control	Setting
EMC-10	
ALL SWITCHES	NA
EMC-25R	
ATTENUATOR	As Required
TUNING DIAL AND FINE TUNE	As Required
AFC SWITCH	MAN
SWEEP BUTTON	NA
TUNING AID	OFF
DUMP	NA
THRESHOLD	NA
DETECTOR	NA
CAL	As Required
BANDWIDTH	As Required
SHUNT	NA
SERIES	NA
BAT. TEST	NA
AUDIO	CCW
BAND SWITCH	NA
POWER	ON
SPD-125	
POWER	ON
SWEEP SPEED	50 MSEC/CM OR SLOWER
TRIGGERING LEVEL	AUTO
TRIGGERING SOURCE	LINE
TRIGGER COUPLING	NA
TRIGGER SLOPE	NA
INTENSITY	As Required
SWEEP	NORM
ASTIG	As Required
FOCUS	As Required
SCALE ILLUM	As Required
FUNCTION SWITCH	SPECTRUM
POSITION SWITCHES	As Required
DISPERSION	As Required

Control	Setting
SPD-125 (Cont'd.)	
FILTER	As Required
DISPLAY	LOG
ATTEN	NA
CONTROL CENTER	
PEN (1)	SPD DET
FREQUENCY CONTROL	SPD
CAL LEVEL SWITCHES	NA
SPEAKER	OFF
DE-EMPHASIS	OFF
EXY-125A (EXY-250)	
POWER	STBY
PEN LIFT	PEN UP
ESC-125A	
POWER	ON
OPERATING SWITCHES	STOP
MODE SWITCHES	MAN
BAND SWITCHES	As Required
SECTOR CONTROLS	NA
METER PANEL	
SELECTOR SWITCH	NA
RANGE SWITCH	OFF

calibrated in amplitude for all bands and in frequency for those bands covering 25 MHz to 1 GHz. Paper calibration and reproduction are integral parts of operation in the X-Y plot mode and must be done with great care to insure accuracy. Refer to paragraph 3.9.3.2 of this manual and Section III of the Electro-Scan Programmer manual for details pertaining to this procedure.

3.9 SPECIFIC OPERATING PROCEDURES

FSS-250 operation can be divided into three major modes and several sub-modes. The major modes are X-Y plot, Quick-Look, and Manual. Normally, all system components are turned on and switch-over can be accomplished rapidly. The removal of any instrument from the system disables its function but in no way disturbs other system functions. The ESC-125A Programmer controls the band in use; if removed, band changes must be made manually and the SU-125 will become inoperative.

3.9.1 SYSTEM POWER. Turn on all POWER switches. Turn the SPEAKER switch on the Control Center to the desired position. After 10 seconds momentarily depress the RESET pushbutton of the ESC-125A and allow 15 minutes for all instruments to stabilize before taking data.

When shutting down, it is necessary to maintain power on the FSS-250 if the EMC-10 and EMC-25R have been battery operated during the previous operation period. Sufficient trickle charge is supplied in normal operation to maintain full battery charge.

3.9.2 INPUTS. Before operating the FSS-250, the Switching Unit(s), SU-125, should be programmed and connected. Figure 2.3 shows the connections between the SU-125 and the FSS-250. Programming and external connections for the most commonly used antennas are shown in Figure 3.3. Paragraph 5.2 of the ESC-125A manual gives details of more general programming methods.

3.9.3 X-Y PLOTTING. To plot an amplitude versus frequency contour on prepared graph paper see Table 3-1 for recommended control settings. Note that control settings differ for best wideband or narrowband sensitivity, and also depend upon the use of peak, average or simultaneous peak and average (FSS-250D only) recording.

The setting of input attenuators is very important. The EMC-10 RANGE controls are set by placing the system in the Manual Mode in the 0-16 KHz band and then adjusting them per paragraphs 3.7.3 and 3.7.4 in the EMC-10 instruction manual.

If a Programmable Step Attenuator PSA-125 is included it should be set as required for the expected input signal levels in the 14-KHz to 1-GHz range. If no PSA-125 is included, the EMC-25R ATTENUATOR setting must be adjusted for best performance. For greatest dynamic range, set the EMC-25R RF ATTENUATOR to 40 DB (black). Highest sensitivity is obtained at 0 DB (black).

3.9.3.1 NORMALIZING THE PLOTTER. The X-Y plotter GAIN and ZERO controls must be normalized for variations in chart size and placement. Additional instructions for adjusting the averaging amplifier controls are contained in paragraph 4.6.

a) Remove the lower plotter decorative trim by pulling straight out. Check switch positions (FSS-250 only). Place PEN 2 control in OFF position (FSS-250D only).
b) Place X-Y Plotter in STAND-BY condition.
c) Insert graph paper keeping its bottom edge against lower rail. The left edge of the paper is placed against the pin protruding from the plotter.
d) Place X-Y Plotter in OPERATE condition.
e) Press the ◄┼► button.
f) Adjust the plotter X and Y ZERO controls to place pen tip over intersection of the ◄┼► arrows.
g) Press the ▲┼▼ button.
h) Adjust the plotter X and Y GAIN controls to place pen tip over intersection of the ▲┼▼ arrows.
j) Repeat steps e. through h. until no further adjustment is needed.

3.9.3.2 CALIBRATION CHECK. If charts have been prepared and reproduced and it is desired to determine if the calibration is still correct, use the following procedure:

a) Insert precalibrated graph paper and normalize plotter per paragraph 3.9.3.1.
b) Set CAL LEVEL controls to a level compatible with all bands.
c) Press CAL and START buttons.
d) At end of program, examine graph to determine if requisite accuracy is obtained.

3.9.3.3 CALIBRATION OF CHART PAPER

NOTE

The EMC-10 must be amplitude and frequency calibrated in the Manual Mode before it can be used for making X-Y plots. Proper control settings for this mode are found in paragraph 3.9.5.1.

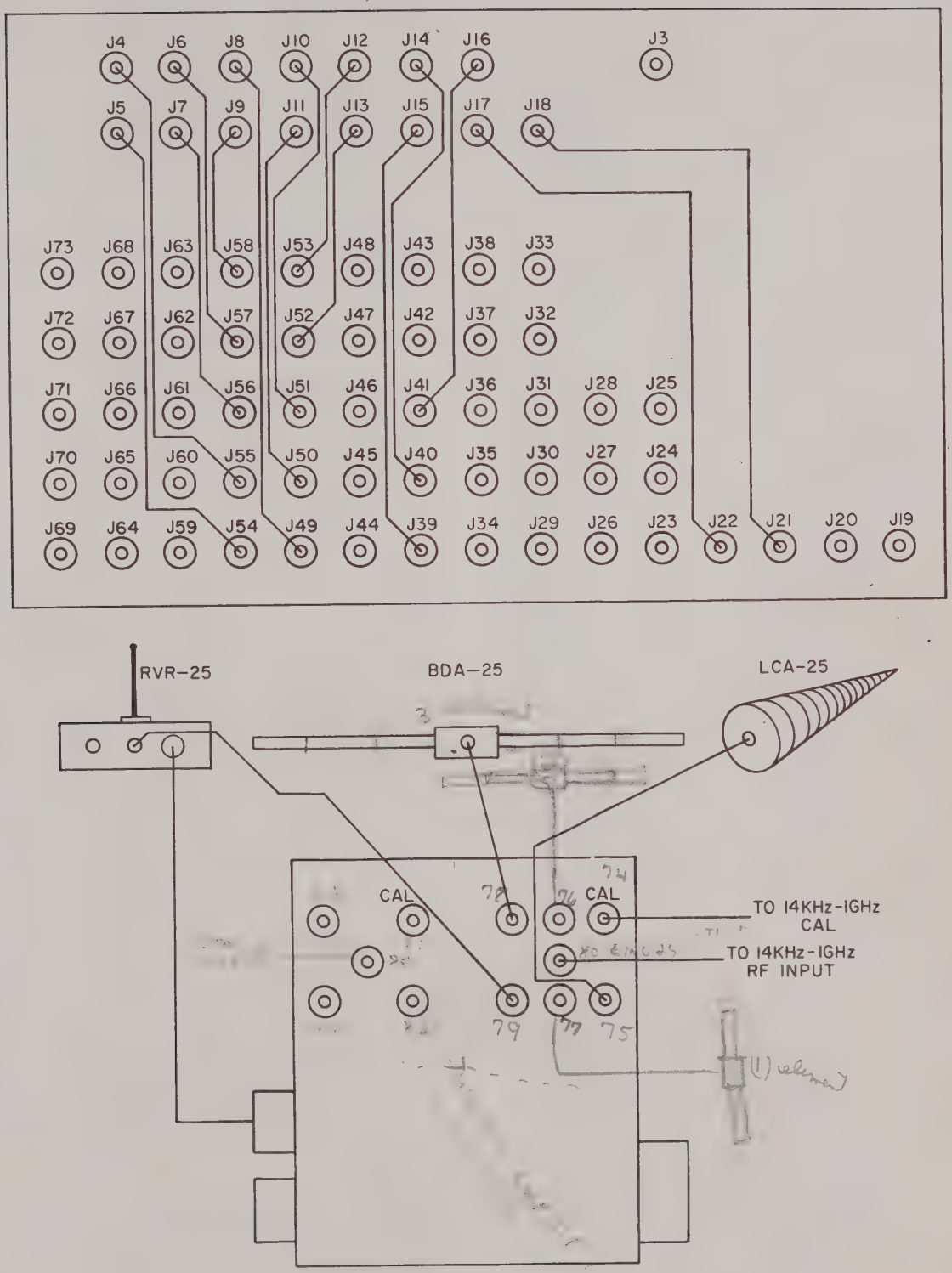


Figure 3.3 Normal Programming of SU-125

Procedures for calibrating the EMC-10 are found in paragraph 3.12 of the EMC-10 instruction manual.

a) Insert preprinted graph paper and normalize plotter per paragraph 3.9.3.1.
b) Set EMC-25R CAL control to either its known optimum position or to mid-position if this is the first calibration.
c) Set EMC-10 controls for full scale amplitude calibration per paragraph 3.12 of EMC-10 instruction manual.
d) Press CAL button.
e) Adjust CAL LEVEL controls for a level which is at or above EMC-25R saturation level.
f) Press START button to obtain saturation calibration line.
g) Set Programmable Step Attenuator, Model PSA-125 (if included), to MANUAL and TERMINATION. If no PSA-125 is included, set EMC-25R ATTENUATOR to 100 DB (black) and set CAL LEVEL controls to -6 DB/uV/MHz.
h) The EMC-10 WIDEBAND and NARROWBAND range controls must now be set for the expected range of input signals. Missetting the WIDEBAND RANGE control can result in the display of numerous spurious signals. If the range of input signals is unknown the FSS-250 must be reset to the Manual Mode and operated per paragraph 3.13 of the EMC-10 instruction manual.
i) Press START button to obtain noise level calibration curve.
j) Repeat steps e. and f. at various levels lower than the saturation value to obtain a family of EMC-25R curves. These curves represent broadband calibration level at the rear connector panel. Antenna factors, cable factors, narrowband conversion factors and specification limits must be added to these curves.
k) The remainder of the family of curves for the EMC-10 are plotted by pulling out the AUDIO control and placing the EMC-10 in the SLIDEBACK mode. The AUDIO control is then adjusted for meter readings 10, 20, 30 and 40 DB below full scale as applicable.
l) Those frequency bands between 25 MHz and 1000 MHz must be frequency calibrated as they are hand-drawn on the EMC-25R scale and therefore, left blank on the multiband chart paper. Details are found in paragraph 3.10.1.1 of the ESC-125A instruction manual.

3.9.3.4 PLOTTING

3.9.3.4.1 Multi-Band Plotting

a) Insert preprinted paper and normalize the plotter.
b) Set band switches as desired.
c) Set PSA-125 and other option controls as required.
d) Press the SINGLE-SCAN button if it is desired to scan all selected bands once. Alternately the MULTI-SCAN button may be pressed to cause the program to repeat indefinitely until the STOP button is pressed.

3.9.3.4.2 Single-Band Plotting

a) Set all band switches except the one desired to the down position.
b) Insert preprinted graph paper and normalize the plotter using only the ZERO controls.
c) Set Sector Limit controls. They are calibrated in terms of percentage of a band.

NOTE

1. Further detail on automatic plotting is found in Section III of the ESC-125A instruction manual.
2. The SCAN RATE control must be set commensurate with the plotted function. For recording in PEAK, WIDEBAND, with the EMC-10 BANDWIDTH selector set to 250 Hz, the maximum scan rate of 10 sec/band (Multi-band) may be used if there are no signal intercept considerations.

3.9.4 QUICK-LOOK MODE. To obtain an amplitude versus frequency display on the SPD-125 Spectrum Display Module, the frequency control switch on the Control Center must be set to SPD and the MAN pushbutton pressed on the ESC-125A Programmer. The EXY-125A Plotter mode switch must be set to STANDBY. In this mode, the frequency of the EMC-25R is controlled by the SPD-125. Band control is exercised by the ESC-125A.

3.9.4.1 USING THE DISPLAY

a) Press and release the STEP button on the ESC-125A Programmer until the light beneath the desired band is illuminated.
b) Turn the Mode switch of the SPD-125

to the SPECTRUM position. When the EMC-25R frequency indicating dial stops, the octave band indicated by the EMC-25R frequency dial will be displayed on the scope face.

NOTE

Further details concerning signal display on the SPD-125 are found in Section III of the CSR-200 instruction manual.

3.9.5 MANUAL OPERATION. The manual mode is used to obtain metered indication of all detector functions offered on the EMC-10 or EMC-25R.

3.9.5.1 RETRACING THE X-Y PLOT

a) Place the frequency control switch on the Control Center in the ESC position.
b) Depress the MAN button on the ESC-125A. Using the STEP button, advance the Programmer state until the indicator for the desired band lights.
c) Tune the EMC-10 or EMC-25R FREQUENCY controls to move the pen or pens along the plot. If the STOP switch is pressed the pens will be raised. If the START button is pressed the pens will be lowered (after a short delay).
d) The EMC-10 and EMC-25R detector function controls may be adjusted and the meters read in this mode according to the respective instruction manuals. The SPD-125 will produce a time domain display if the mode switch is set to the VIDEO position.

3.9.5.2 MANUAL CONTROL - ALTERNATE METHOD

a) Set the frequency control switch on the Control Center to the SPD position and the Mode switch on the SPD-125 to VIDEO.
b) Press the MAN and STOP buttons or the CAL and STOP buttons of the ESC-125A as required having previously selected the desired band.
c) Tune the EMC-25R FREQUENCY control to the desired frequency. The meter may be read as before.

3.9.6 TIME DOMAIN DISPLAY. This mode of operation is used to obtain a permanent record of a 10 to 200-second time segment at a fixed frequency. Although any of the detector functions of the EMC-25R may be plotted in this mode, it is recommended that only the PEAK scan detector function be used. Control settings are made as referenced in paragraph 3.9.5.2 above with the ESC-125A set for Single Band (SECTOR) operation in the desired band. The SPD-125 time base controls may be adjusted for synchronization with an external source and to initiate the time sweep at a convenient point. At this point in Model FSS-250D systems the plotter pen is dropped by switching the PEN 1 switch from NORM to PEN DROP. At the end of the trace it must be manually reset to the NORM position to lift the pen. In Model FSS-250 systems the EXY-125A PEN switch is similarly moved to the DOWN position. To calibrate the paper the CAL and STOP buttons must be pressed on the ESC-125A to operate the impulse calibrator.

SECTION IV
SERVICE AND MAINTENANCE

4.1 GENERAL

Servicing intervals are referenced to the Band Counter dial reading. Every 2000 counts it is recommended that the calibration of the prepared chart paper be checked. At intervals of 10,000 counts, check the CSR-200 and ESC-125A as directed in the respective manuals. In event of failure, use the meter test panel first to see if the power supplies are operating within the correct range.

4.2 EQUIPMENT ACCESS

Access to cabling and power connections is at the rear of the cabinet. Individual items are serviced in the following order: EMC-10, EMC-25R, SPD-125, EXY-125A, EXY-250, ESC-125A and Control Center.

4.2.1 REMOVAL OF INSTRUMENTS FOR ALIGNMENT. All power should be off before removing any instrument.

4.2.1.1 ESC-125A

a) Remove four screws from rear of ESC-125A.
b) Push on rear panel of ESC-125A until front extends about one inch from housing. Pull ESC-125A all the way out of housing from front, and rest frame on console table.

4.2.1.2 SPD-125

a) Remove cables from front of SPD-125.
b) Remove four mounting screws from front of SPD-125.
c) Pull SPD-125 out on rack slides until it reaches locking position.
d) Remove side cover near vertical plug-in by turning two screws.
e) Connect extension cable provided between SPD-125 control connector and control cable (# 4666-1).
f) Add coaxial extension to coaxial cable and connect to front of SPD-125.

4.2.2 PROCEDURE FOR REMOVING INSTRUMENTS. When removing any instrument all of the instruments in the system should be turned off and the main power cord should not be plugged into a power outlet.

4.2.2.1 EMC-10

a) Disconnect all cables from front panel (input, probe, cal-tracking, remote control).
b) Remove cables from under handles of instrument.
c) Unplug power cord from rear of instrument.
d) Remove four screws that mount EMC-10 to rack console.
e) Pull EMC-10 out of console by using handles provided. EMC-10 will slide on rack slides until it reaches a stop.
f) Lift locking levers on each side of rack simultaneously and pull EMC-10 completely out of console.
g) Place slides that are protruding from console back into console by lifting rear locking levers and pushing back into console.

4.2.2.2 EMC-25R

a) Disconnect all cables from front panel (RF INPUT, IG OUTPUT, AM VIDEO, and REMOTE).
b) Remove these cables from under handles of EMC-25R.
c) Disconnect POST IF cable and power cord from rear of EMC-25R.
d) Remove four screws that mount the EMC-25R to console.
e) Remove EMC-25R out of console by using handles provided. EMC-25R will slide on rack slides until it reaches a stop.
f) Lift locking levers on each side of rack simultaneously and pull EMC-25R completely out of console.
g) Place slides that are protruding from console back into console by lifting rear locking levers and pushing back into console.

4.2.2.3 SPD-125

a) Disconnect all cables from front panel (remote control, AM video, and post IF).
b) Remove these cables from under handles of SPD-125.
c) Disconnect power cord from rear of SPD-125.
d) Remove four screws that mount SPD-125 to console.
e) Pull SPD-125 out of console by using handles provided. SPD-125 will slide on rack slides until it reaches a stop.
f) Lift locking levers on each side of rack simultaneously and pull SPD-125 completely out of console.
g) Place slides that are protruding from console back into console by lifting rear locking levers and pushing back into console.

4.2.2.4 EXY-125A

a) Remove cable with fanning strip from rear of EXY-125A.
b) Unplug EXY-125A power cord from outlet in back of FSS-250.
c) Remove aluminum covers from front of EXY-125A.
d) Remove four screws and brass cams from corners.
e) Lift out EXY-125A. It may be easier for two people to lift out the EXY-125A.

4.2.2.5 EXY-250

a) Follow steps a. through d. in paragraph 4.2.2.4.
b) Remove knobs from ZERO and GAIN controls.
c) Remove nuts from ZERO and GAIN control and remove escutcheon.
d) Pull ZERO and GAIN controls from holes in console from rear of console.
e) Lift out EXY-250.

4.2.2.6 ESC-125A

a) Disconnect all remote control cables from rear of ESC-125A (EMC-10, Plotter, Switching Unit, EMC-25R, Control Center).
b) Disconnect power cord from rear of ESC-125A.
c) Remove four screws that mount the ESC-125A to console.
d) Pull ESC-125A out of console by using handles provided. ESC-125A will slide on rack slides until it reaches a stop.
e) Lift locking levers on each side of rack simultaneously, and pull ESC-125A completely out of console.
f) Place slides that are protruding from console back into console by lifting rear locking levers and pushing back into console.

4.2.2.7 CONTROL CENTER

a) Disconnect cables with fanning strips from rear of Control Center.
b) Disconnect cable connected to speaker jacks at rear of Control Center.
c) Disconnect cable with multi-pin connector (to meter panel) at rear of Control Center.
d) Disconnect SPD-125 control cable from front of SPD-125 and push cable to rear of console.
e) Disconnect ESC-125A Control Center cable at rear of ESC-125A.
f) Cables mentioned in steps d. and e. should be removed from all cable clamps.
g) If FSS-250D, remove coaxial cables from rear of Control Center.
h) Remove two screws (one on top and one on bottom) from front of Control Center.
i) Lift Control Center out of console by using handles provided.

4.3 PERIODIC SERVICE/CALIBRATION

4.3.1 2000 COUNT CALIBRATION. Each time the band counter advances 2000 counts it is recommended that an accurate check of all calibration lines be made on the precalibrated paper. Any deviation in excess of 5 DB indicates the need for further service.

4.3.2 10,000 COUNT CALIBRATION. Each time the band counter advances 10,000 counts perform the same procedure as for the 2000 calibration. In addition the SPD-125 should be operated in all modes with signals at each end of any one of the bands 1-7; any band 8-10; and any band 11-15. All options provided should be operated in all modes. Power supplies should be checked per Table 4-1 using the meter panel. Readjustment of internal potentiometers is recommended only when an out-of-tolerance condition is indicated. No regular adjustment is necessary.

4.3.3 ORDER OF CALIBRATION

a) Place dummy plugs on EMC-10 and EMC-25R and operate manually according to respective instruction manuals. Using checkout sheets, determine if operation is normal.
b) If abnormal, remove for servicing according to paragraph 4.2.

c) Place Control Center SPD-NORM switch or PEN 1 switch in NORM position and SPD-ESC switch in ESC position.
d) Operate Programmer as required to produce both single-band and multi-band calibration charts.
e) If sweep timing, offset or gain is unsatisfactory, remove ESC - 125A chassis per paragraph 4.2 and align per its instruction manual.
f) Place Control Center SPD-ESC switch in SPD position. Place EXY switch in STANDBY position.
g) Operate SPD-125 according to CSR-200 instruction manual in both LOG and LIN in all four modes available at MODE switch.
h) Unsatisfactory contrast ratio or display linearity can be corrected by readjustment of front panel controls.
i) If any other parameters of SPD-125 are unsatisfactory it must be removed per paragraph 4.2 for servicing or readjustment.
j) No alignment of Control Center is necessary. Fine adjustment for CAL LEVEL controls is located on ESC-125A front panel. It is factory set and fed by a regulated power supply so the need for realignment is extremely unlikely.
k) A check of option operation is the last step. Proper operating parameters are covered in the addendum inserted in this manual for the particular option.

4.4 TROUBLESHOOTING

The first step is to follow the procedures outlined in paragraphs 4.3.1 and 4.3.2 of this manual.

The second step is to check the power supply voltages per Table 4-1 using the meter panel. The panel meter is accurate to ±2%. For greater accuracy, a DVM may be plugged into the two banana jacks on the front panel.

Any voltage reading outside the limits shown in Table 4-1 indicates that the instrument in question is in need of servicing. Service instructions for individual instruments are contained in their respective instruction manuals. Theory of operation and operation methods for the Control Center are contained in this manual (Sections II and III).

4.5 REPLACEABLE ASSEMBLIES

Replaceable assemblies are limited to EMC-10, EMC-25R, SPD-125, ESC-125A and EXY-125A and those parts listed in their manuals as replaceable.

TABLE 4-1

POWER SUPPLY METER READINGS

Switch Position	Equipment Monitored	Voltage Limits (Volts DC)
1	EMC-25R	+11.85 to +12.15
2	EMC-25R	-6.15 to -5.85
3	EMC-25R	+14.0 to +23.0
4	EMC-25R	-9 to -14.5
5	EMC-10	-11.85 to -12.15
6	EMC-10	+11.85 to +12.15
7	ESC-125A	+11.85 to +12.15
8	ESC-125A	-11.85 to -12.85
9	ESC-125A	+22 to +28
10	ESC-125A	+3.5 to +3.7

4.6 PEN 2 ALIGNMENT

PEN 2 in FSS-250D systems must be realigned at 10,000 count intervals to agree with PEN 1. Four screwdriver adjustments on the Control Center panel should be used as follows to align the second pen.

When the PEN 2 switch on the Control Center is in the OFF position, press the ◄┼► button on the Programmer. Using the PEN 2 ZERO control of the X-Y plotter, adjust the pen to line up with PEN 1. After doing this, press the ▲┼▼ button on the Programmer. Using the PEN 2 GAIN control of the X-Y plotter, adjust the pen to line up with PEN 1. Repeat until pen position does not change.

Change the PEN 2 switch on the FSS-250D Control Center to the ON position. Feed a CW signal into the EMC-25R RF input and adjust for 20 DB above the noise on the meter. Select only a single band on the Programmer. After tuning in on the CW signal, adjust the SINGLE BAND ZERO adjust potentiometer on the Control Center such that PEN 2 lines up with PEN 1. Increase the CW signal for a meter reading of 10 DB over full scale on the EMC-25R. Adjust the SINGLE BAND GAIN adjust potentiometer on the Control Center such that PEN 2 lines up with PEN 1. Repeat until the PEN 2 position does not change.

Select more than one band of the Programmer. Tune in on a CW signal and repeat procedure in above Programmer except use the MULTI-BAND ZERO and GAIN controls on the Control Center.

4.7 TUNING OF REJECTION FILTER

The rejection, or notch filter, described in paragraph 2.2.12 is located in cable 4657-1 , between the ESC-125A and EMC-25R, and is normally tuned to 120 Hz. This filter may also be tuned to 100 Hz when a 50 Hz power supply is used. The following is the procedure for tuning the filter.

Disconnect cable 4657-1 from the ESC-125A and the EMC-25R. Remove the cover on the box containing the filter. Referring to Figure 4.1, inject a 120 Hz CW signal at input terminal 3, and use terminal 2 as ground. Connect a VTVM such as the HP400H to output terminal 1. Adjust pot A, then pot C, and finally, pot B for a null. Repeat adjustments of the three pots until no further decrease in output is read on the voltmeter. The notch should be a minimum of 40 DB. Replace the cover and reconnect the cable. Refer to connector markings to be sure the cable is properly connected.

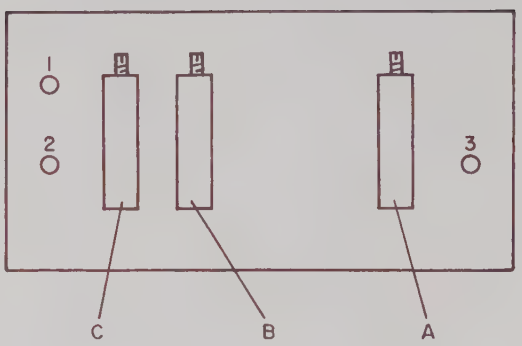


Figure 4.1 Location of Tuning Filter Adjustments

SECTION V
OPERATION OF OPTIONS

5.1 GENERAL

The versatility of the FSS-250 system can be enhanced through the addition of a number of options. The key to the operation of these options is the availability of all programming functions at terminal points in the Control Center (Figure 5.1).

5.2 AUXILIARY PROGRAMMING

Table 5-1 tabulates those programming functions available at the terminals illustrated in Figure 5.1. All functions are non-interacting. Most options are built on 19-inch width rack panels and are installed in the right-hand section beneath the desk after removing one or more of the blank panels. Electrical connections are made to the Control Center terminal blocks with the cable supplied. Instruction sheets and schematics are supplied for the individual options. The most popular programming option, the PSA-125 Programmable Step Attenuator, is described in paragraph 5.2.1.

5.2.1 PSA-125. In some measurement situations, the range of input signal levels may exceed the dynamic range of the EMC-25R. In such cases it is desirable to program the insertion of fixed amounts of attenuation into the input line on a band-by-band basis. The PSA-125 is a 0, 20, 40, 60, 80 DB and termination step attenuator (other values are obtainable) whose position is determined by the setting of 17 thumbwheel switches corresponding to the 16 bands and one manual station.

Switch wafers on the same shaft as the type MA-600 attenuator are arranged to step until a ground is reached. This position is determined by which of the six input lines is grounded. This ground is provided through either S17 in series with the MANUAL-AUTOMATIC switch or through S1 through S16 and Q7 through Q22 respectively, then through the MANUAL-AUTOMATIC switch. The bases of transistors Q7 through Q22 are connected to the band indication terminals in the Control Center. Only one of these terminals is high (+2.0 to +3.6 volts) at a time, resulting in only one of the transistors being saturated; all others are cut off. Thus only one path to ground is completed at a time.

Transistors Q1 through Q6 sense which line is grounded and illuminate the appropriate neon indicator. This circuit is shown in Figure 6.8.

5.3 INPUT SWITCHING

Some FSS-250 models are provided with more than one Switching Unit, SU-125. This provision is made so that instantaneous changes in test mode (radiated or conducted) can be made without the necessity for changing coaxial connections or reprogramming the internal plug-boards of the SU-125.

A toggle switch located on the Control Center actuates coaxial relays within the FSS-250 enclosure and opens the common control lead to the unused SU-125. Extra connectors for control and RF connections are provided on the FSS-250 rear panel.

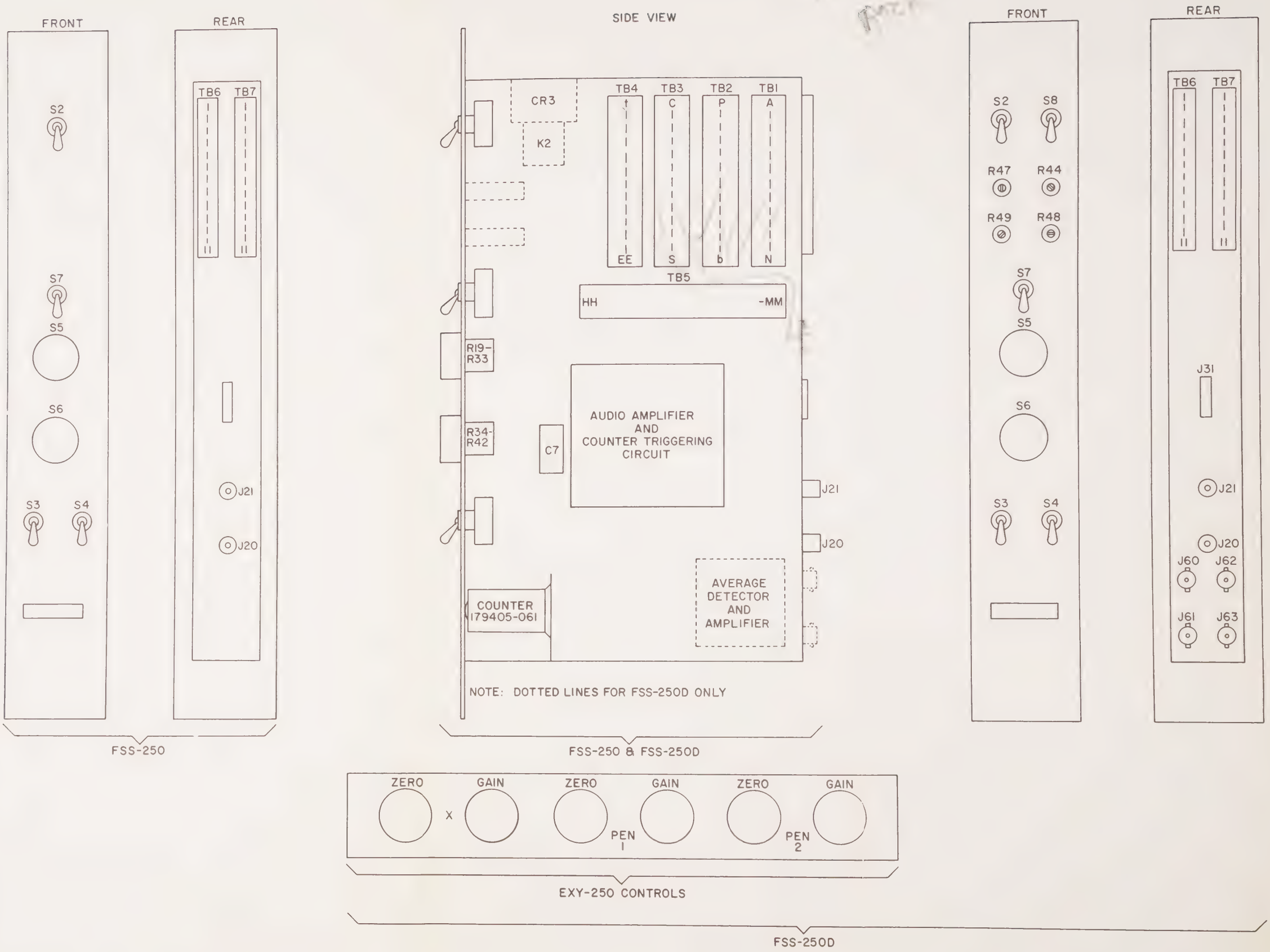


Figure 5.1 Control and Terminal Location

TABLE 5-1

CONTROL CENTER BARRIER STRIP FUNCTIONS

FUNCTION	TERMINAL	REMARKS
PROGRAMMABLE FUNCTIONS		
EMC-25R		
Tuning Input	TB2-Y	0 - +1.5V nominal
Bandwidth Command	TB2-b	+12V = N.B., -6V = W.B.
GAIN	TB3-c	0 - +12V varies gain 20 DB (normally connected to TB1-B)
Dump Command	TB3-d	EMC-25R's below serial #140; -6V to dump EMC-25R's serial #140 and above; +12V to dump
AFC	TB1-H	Ground defeats AFC
IG Contacts	TB2-W	-300V - +300V (when CAL switch is depressed)
EXY-125A (FSS-250)		
+X	TB6-1	
-X	TB6-2	
+Y	TB6-3	
-Y	TB6-4	
Pen Drop	TB6-6 TB6-7	Contact closure to drop pen
EXY-250 (FSS-250D)		
+X	TB6-1	
-X	TB6-2	
+Y	TB6-3	Pen 1 (PEAK)
-Y	TB6-4	Pen 1 (PEAK)
+Y'	TB6-5	Pen 2 (AVERAGE)
-Y'	TB6-6	Pen 2 (AVERAGE)
Pen 1 Drop	TB6-8 TB6-9	Contact closure to drop pen
Pen 2 Drop	TB6-10 TB6-11	Contact closure to drop pen
OUTPUT FUNCTIONS		
EMC-25R		
AUDIO	TB1-A	
+12V	TB1-B	
Bandwidth Selector	TB2-a	Normally connected to TB2-b
Tuning	TB4-EE	0 - +1.5V variable with tuning dial (normally connected to TB2-Z)
-6V	TB1-C	
+ RAW	TB1-D	
- RAW	TB1-E	
2-Band Logic	TB4-BB	
1-Band Logic	TB4-AA	
4-Band Logic	TB4-CC	
8-Band Logic	TB4-DD	
EMC-10		
+12V	TB1-K	
-12V	TB1-L	
AUDIO	TB1-M	

TABLE 5-1

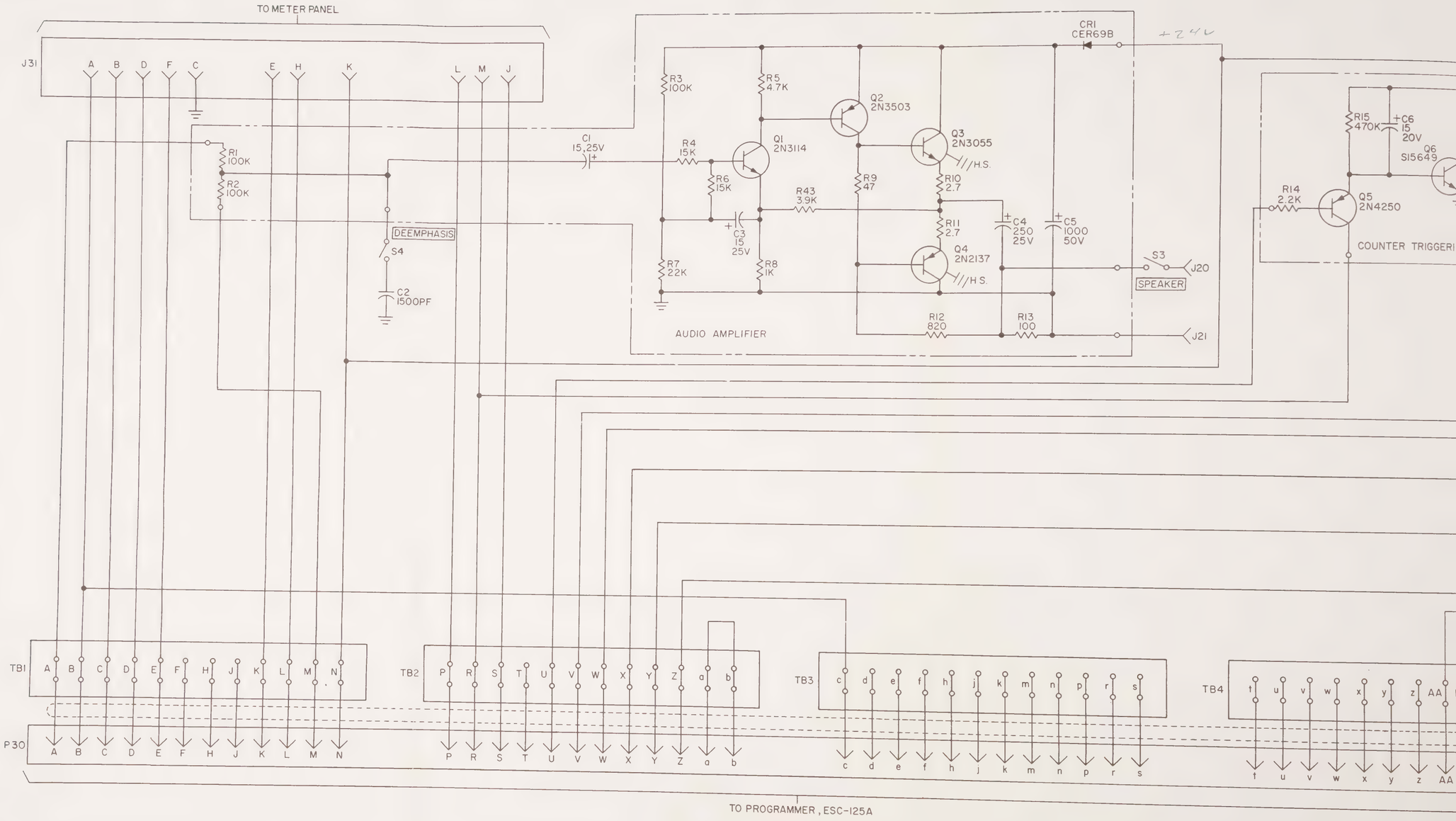
CONTROL CENTER BARRIER STRIP FUNCTIONS (Cont'd.)

FUNCTION	TERMINAL	REMARKS
OUTPUT FUNCTIONS (Cont'd.)		
ESC-125A		
+24V	TB1-N	
+12V	TB2-P	
-12V	TB2-R	
+3.6V	TB2-S	
Band Count	TB2-U	Negative-going pulse
CAL Level	TB2-V	0 - +300V (variable with CAL Level Control)
Tune Voltage	TB2-X	0 - +1.5V
EMC-10 Band Command	TB3-e	TB3-e through TB3-s and TB4-t through TB4-y; only the one representing the band in use is in the "high" state.
Band 1 Command	TB3-f	
Band 2 Command	TB3-h	
Band 3 Command	TB3-j	
Band 4 Command	TB3-k	
Band 5 Command	TB3-m	
Band 6 Command	TB3-n	
Band 7 Command	TB3-p	
Band 8 Command	TB3-r	
Band 9 Command	TB3-s	
Band 10 Command	TB4-t	
Band 11 Command	TB4-u	
Band 12 Command	TB4-v	
Band 13 Command	TB4-w	
Band 14 Command	TB4-x	
Band 15 Command	TB4-y	
+140V	TB4-z	Neon Indicator Supply
Sweep Out	TB7-1	0 - +1.5V Ramp (for X-Y Plotter +X)
-X	TB7-2	For X-Y Plotter -X
Y Output	TB7-3	
-Y	TB7-4	For X-Y Plotter -Y
Pen Drop	TB7-6 TB7-7	Contract closure to drop pen
SPD-125		
Sweep Out	TB5-MM	0 - +1.5V Ramp (for X-Y Plotter +X)
Y Output	TB5-LL	
Tune Output	TB5-C	
MISCELLANEOUS FUNCTIONS		
SPD-125		
Tune Input	TB5-A	
4-Band Logic	TB5-E	
2-Band Logic	TB5-F	
8-Band Logic	TB5-H	
1-Band Logic	TB5-J	

SECTION VI
REFERENCE DATA

6.1 GENERAL

This section contains schematic and cabling diagrams for the FSS-250 and FSS-250D systems. For information on the individual components (EMC-25R, EXY-125, etc.) consult the appropriate manual.


TO METER PANEL
J31
A B D F C E H K L M J
R1 100K
R2 100K
C1 15,25V
DEEMPHASIS
S4
C2 1500PF
CR1 CER69B
+24V
R3 100K
R5 4.7K
Q2 2N3503
Q1 2N3114
Q3 2N3055
H.S.
R4 15K
R6 15K
R43 3.9K
R9 47
R10 2.7
C3 15 25V
R11 2.7
C4 250 25V
C5 1000 50V
Q4 2N2137
H.S.
S3
J20
SPEAKER
R7 22K
R8 1K
R12 820
R13 100
J21
AUDIO AMPLIFIER
R15 470K
C6 15 20V
Q6 S15649
R14 2.2K
Q5 2N4250
COUNTER TRIGGER
TB1 A B C D E F H J K L M N
TB2 P R S T U V W X Y Z a b
TB3 c d e f h j k m n p r s
TB4 t u v w x y z AA
P30 A B C D E F H J K L M N
P R S T U V W X Y Z a b
c d e f h j k m n p r s
t u v w x y z AA
TO PROGRAMMER, ESC-125A

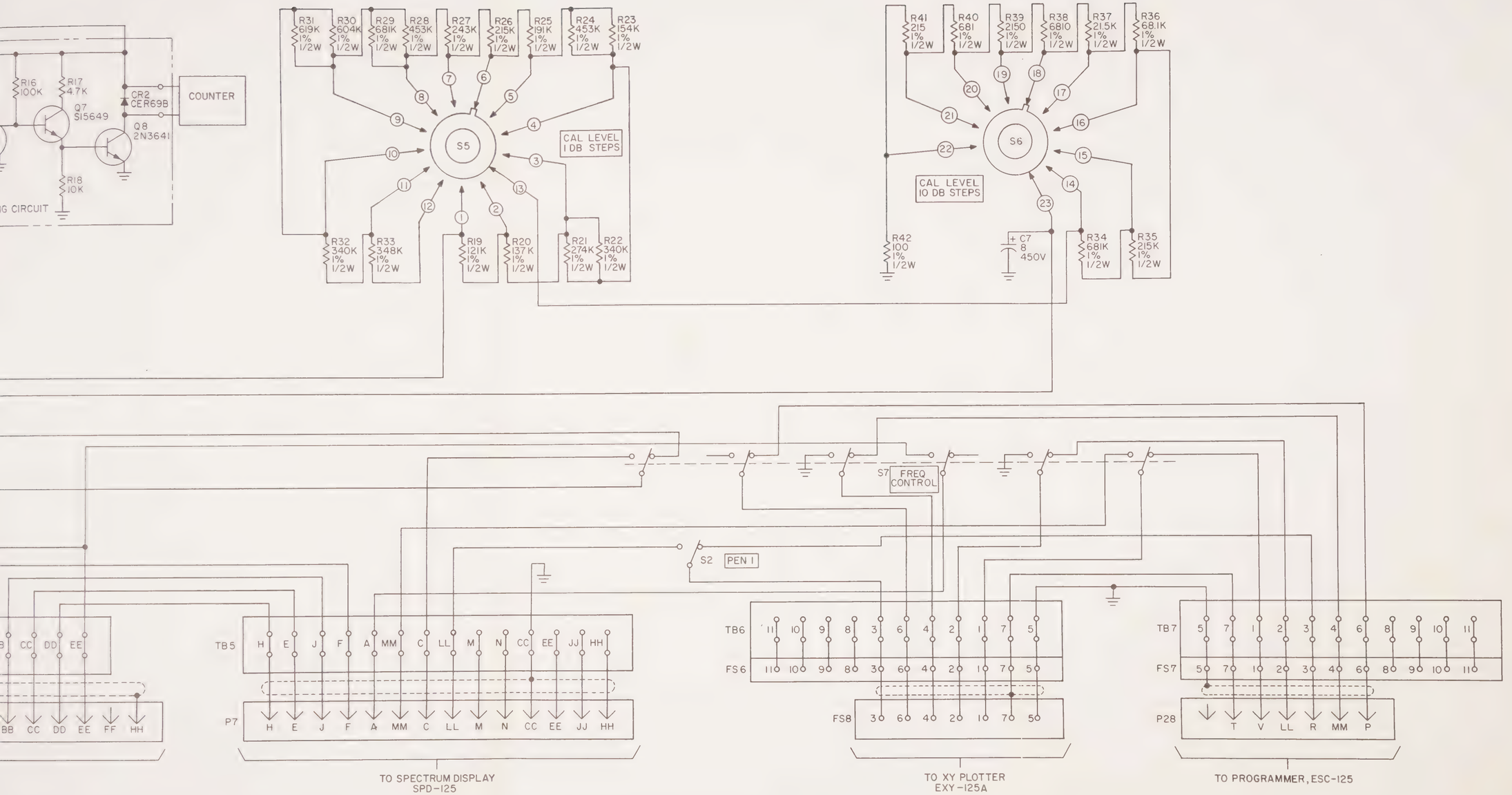
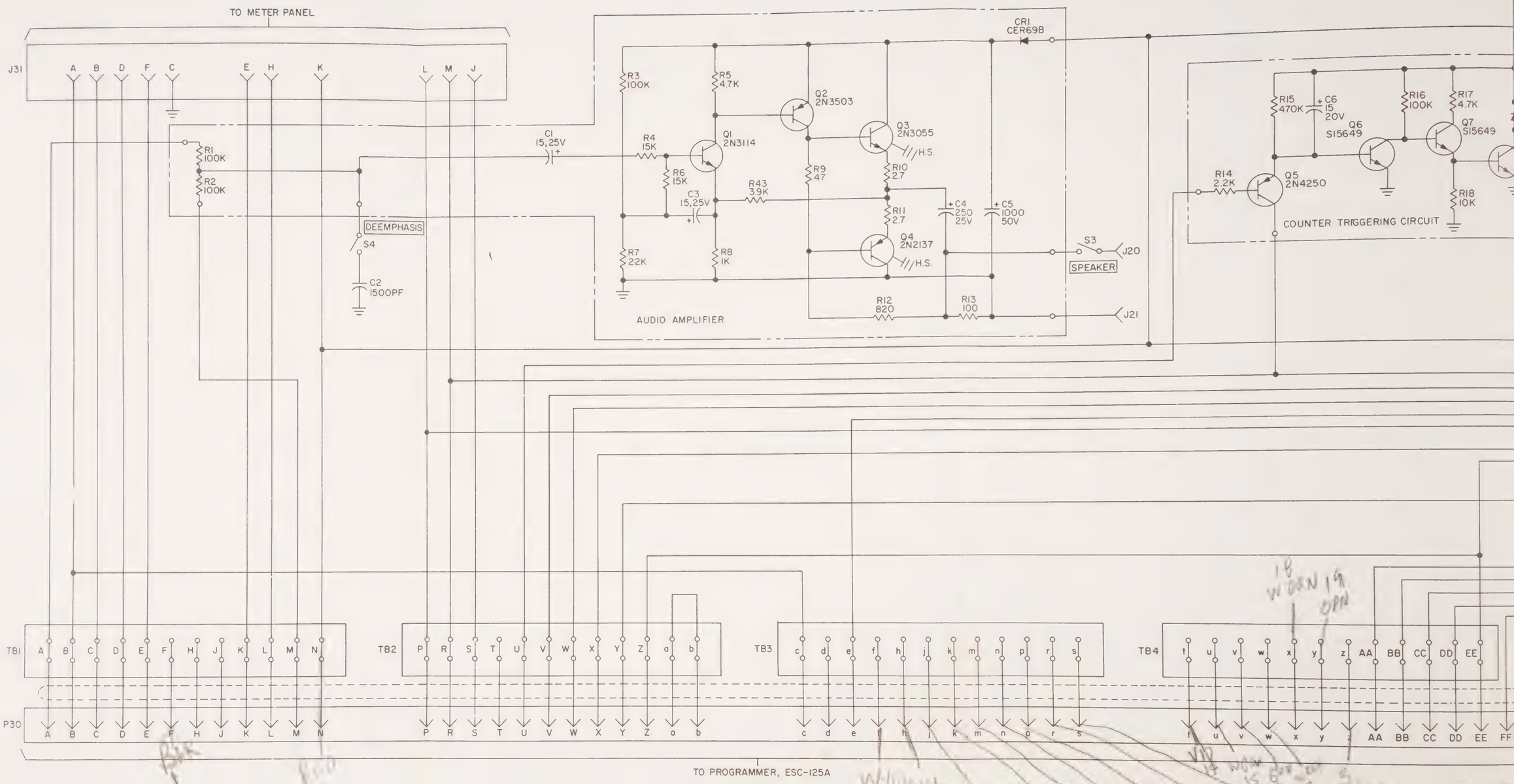


Figure 6.1 Control Center, FSS-250, Schematic Diagram


TO METER PANEL
J31
A B D F C E H K L M J
R1 100K
R2 100K
DEEMPHASIS
S4
C2 1500PF
C1 15,25V
R3 100K
R4 15K
R5 4.7K
Q1 2N3114
Q2 2N3503
Q3 2N3055
H.S.
R6 15K
C3 15,25V
R43 3.9K
R9 47
R10 2.7
R11 2.7
C4 250 25V
C5 1000 50V
CR1 CER69B
R7 22K
R8 1K
Q4 2N2137
H.S.
S3
J20
SPEAKER
R12 820
R13 100
J21
AUDIO AMPLIFIER
R15 470K
C6 15 20V
Q6 S15649
R16 100K
R17 4.7K
Q7 S15649
R14 2.2K
Q5 2N4250
R18 10K
COUNTER TRIGGERING CIRCUIT
TB1 A B C D E F H J K L M N
TB2 P R S T U V W X Y Z a b
TB3 c d e f h j k m n p r s
TB4 t u v w x y z AA BB CC DD EE
P30 A B C D E F H J K L M N P R S T U V W X Y Z a b c d e f h j k m n p r s t u v w x y z AA BB CC DD EE FF
TO PROGRAMMER, ESC-125A

COUNTER

CR2
CER69B

Q8
2N3641

R31 619K 1% 1/2W
R30 604K 1% 1/2W
R29 681K 1% 1/2W
R28 453K 1% 1/2W
R27 243K 1% 1/2W
R26 215K 1% 1/2W
R25 191K 1% 1/2W
R24 453K 1% 1/2W
R23 154K 1% 1/2W

S5

CAL LEVEL
1 DB STEPS

R32 340K 1% 1/2W
R33 348K 1% 1/2W
R19 121K 1% 1/2W
R20 137K 1% 1/2W
R21 274K 1% 1%
R22 340K 1% 1/2W

R41 215 1% 1/2W
R40 681 1% 1/2W
R39 2150 1% 1/2W
R38 6810 1% 1/2W
R37 21.5K 1% 1/2W
R36 68.1K 1% 1/2W

S6

CAL LEVEL
10 DB STEPS

R42 100 1% 1/2W

C7 8 450V

R34 681K 1% 1/2W
R35 215K 1% 1/2W

CR3
CER69B

K2

S8 PEN 2

S7 FREQ CONTROL

S2 PEN 1

K1

Q11
2N3641

J60
J61
J62
J63

R64
22.1K
1%

R5
39

AVERAGE DETECTOR AND AMP

TB5 H E J F A MM C LL M N CC EE JJ HH

P7 H E J F A MM C LL M N CC EE JJ HH

TO SPECTRUM DISPLAY SPD-125

TB6 1 2 3 4 5 6 7 8 9 10 11

FS6 10 20 30 40 50 60 70 80 90 100 110

FS8 10 20 30 40 50 60 70 80 90 100 110

TO XY PLOTTER EXY-250

TB7 1 2 3 4 5 6 7 8 9 10 11

FS7 10 20 30 40 50 60 70 80 90 100 110

P28 V LL R MM P T

TO PROGRAMMER, ESC-125A

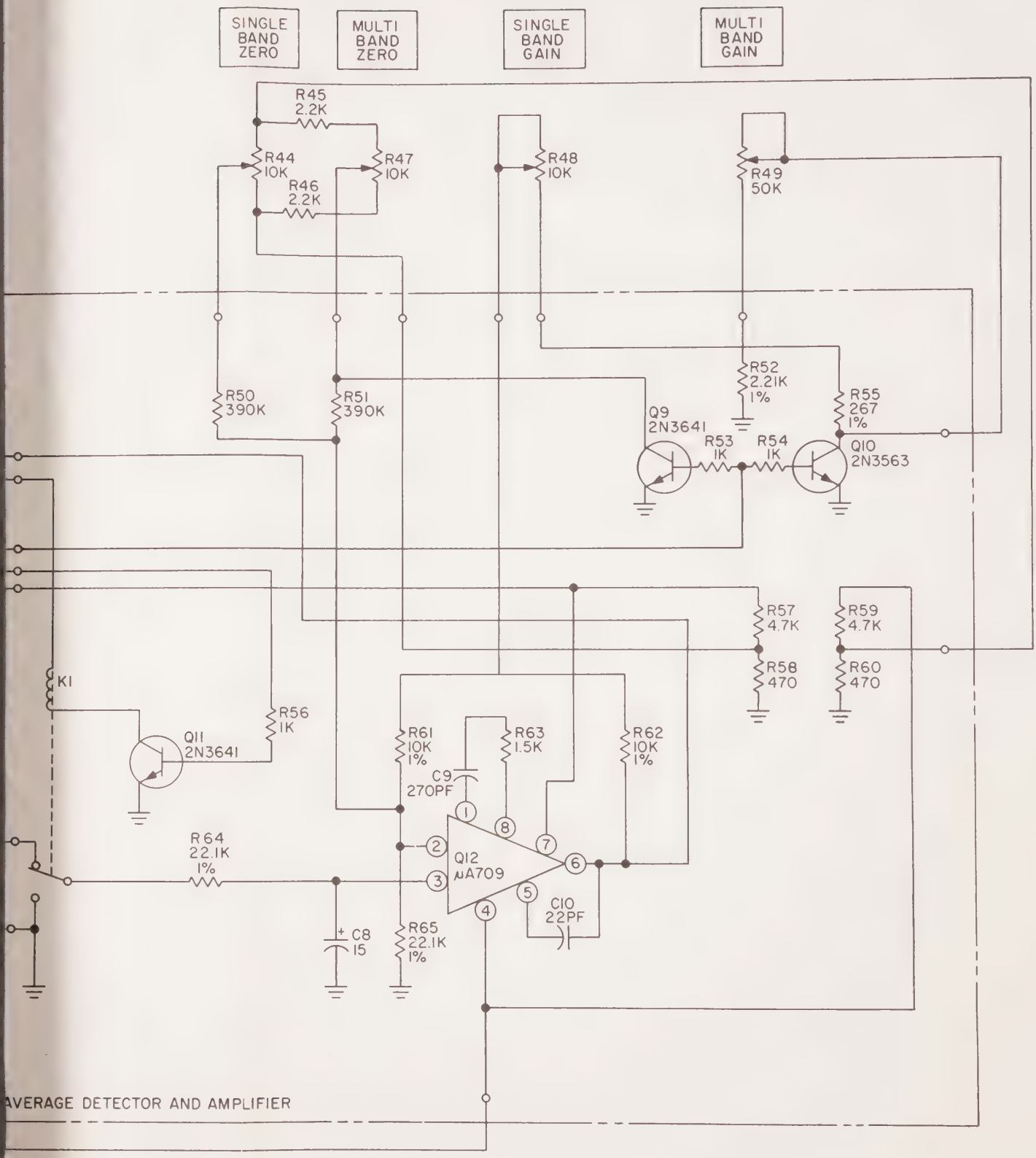


Figure 6.2 Control Center, FSS-250D, Schematic Diagram

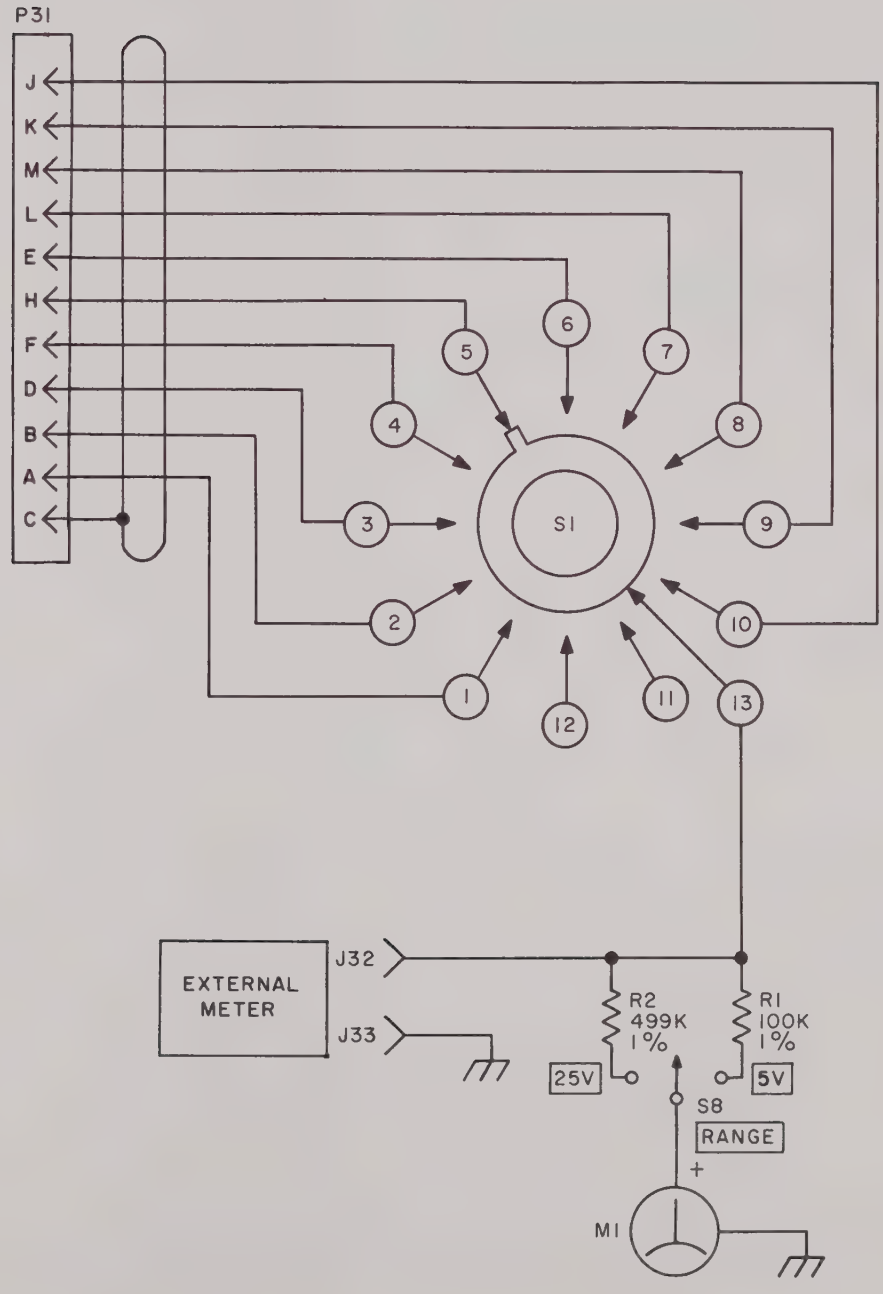


Figure 6.3 Meter Panel, Schematic Diagram

EXTERNAL
JUNCTION BOX
SU-125

P1

J1

(4660-1)

34

SWITCH
UNIT

J29

PROGRAMMER
ESC - 125A

EMC-25

REMOTE

INTERFERENCE
ANALYZER
EMC-25R

AIJ5

P5

(4657-1)

34

C

C

SHIELD

R1
5K

R2
8.2K

R3
6.8K

R4
5K

C1
.15

C2
.15

R5
2K

R6
3.9K

C3
.15

C4
.15

P27

J27

CONTROL
CENTER

PLOTTER

J30

P30

J28

P28

J25

(4658-1)

(4655-1)

50

11

FS7

TB1,2,3,4

TB7

METER PANEL

S1

(4653-1)

10

P31

J31

CONTROL CENTER

SPEAKER

J20

J21

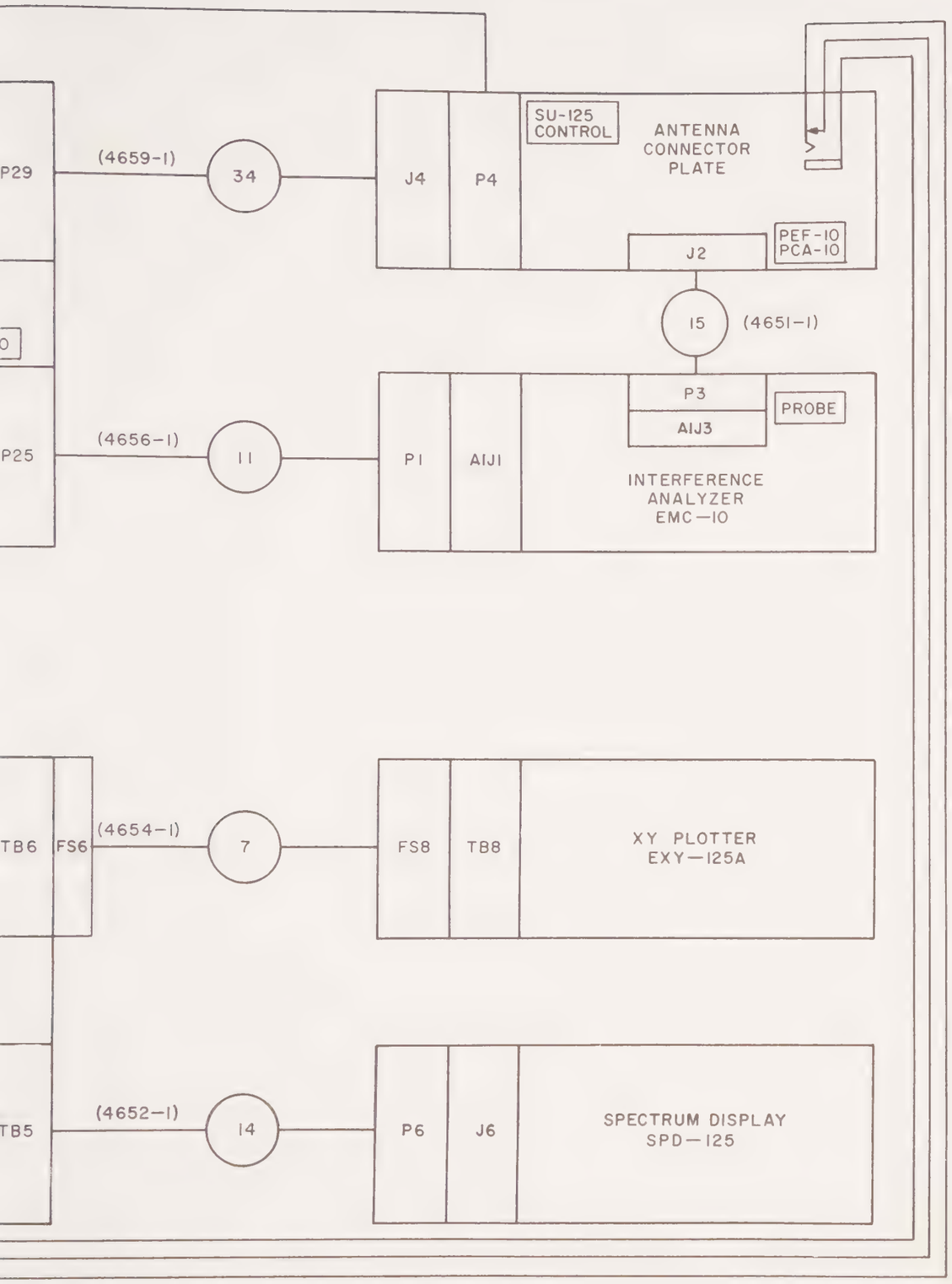


Figure 6.4 FSS-250, System Cabling Diagram

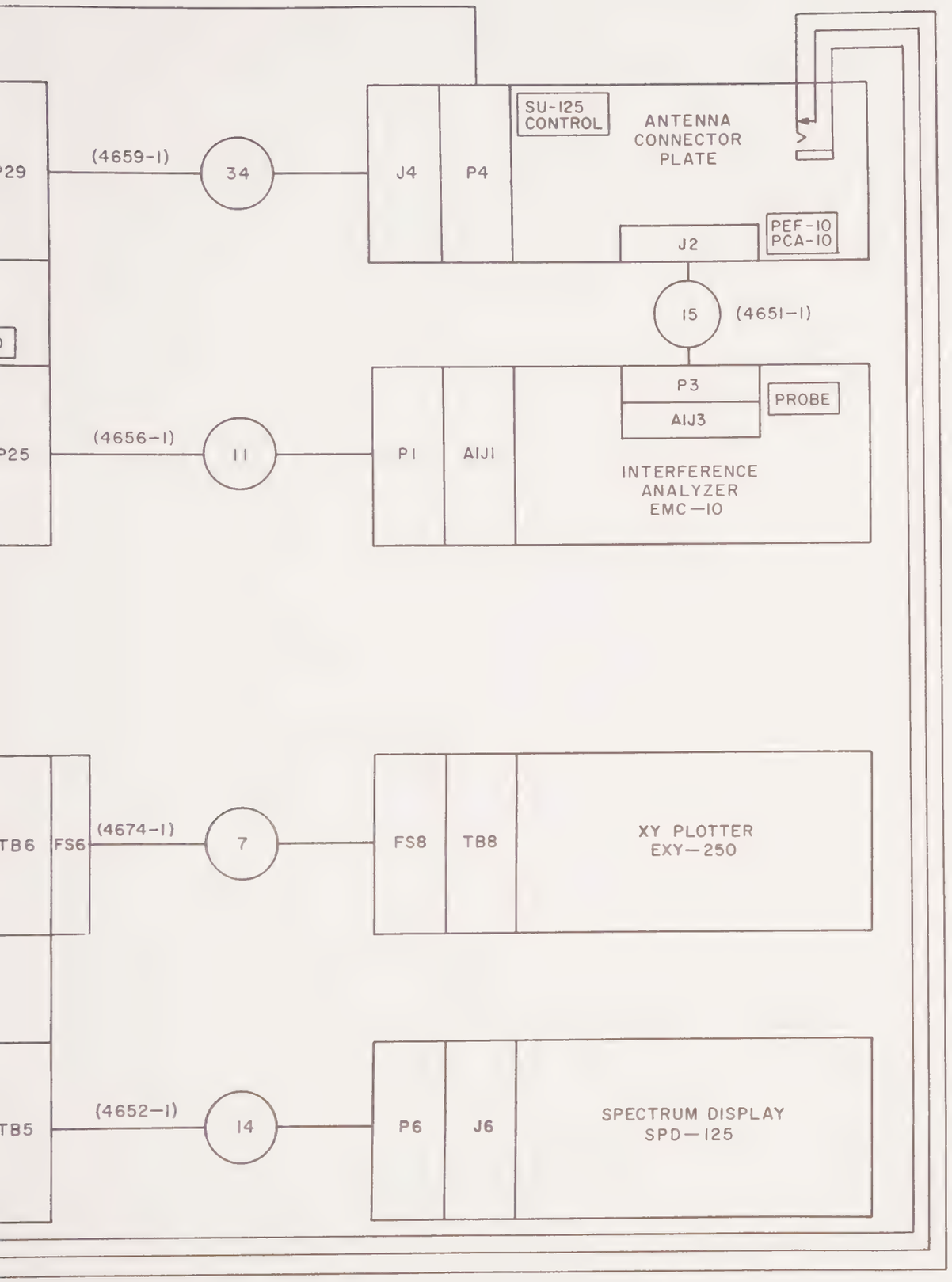


Figure 6.5 FSS-250D, System Cabling Diagram

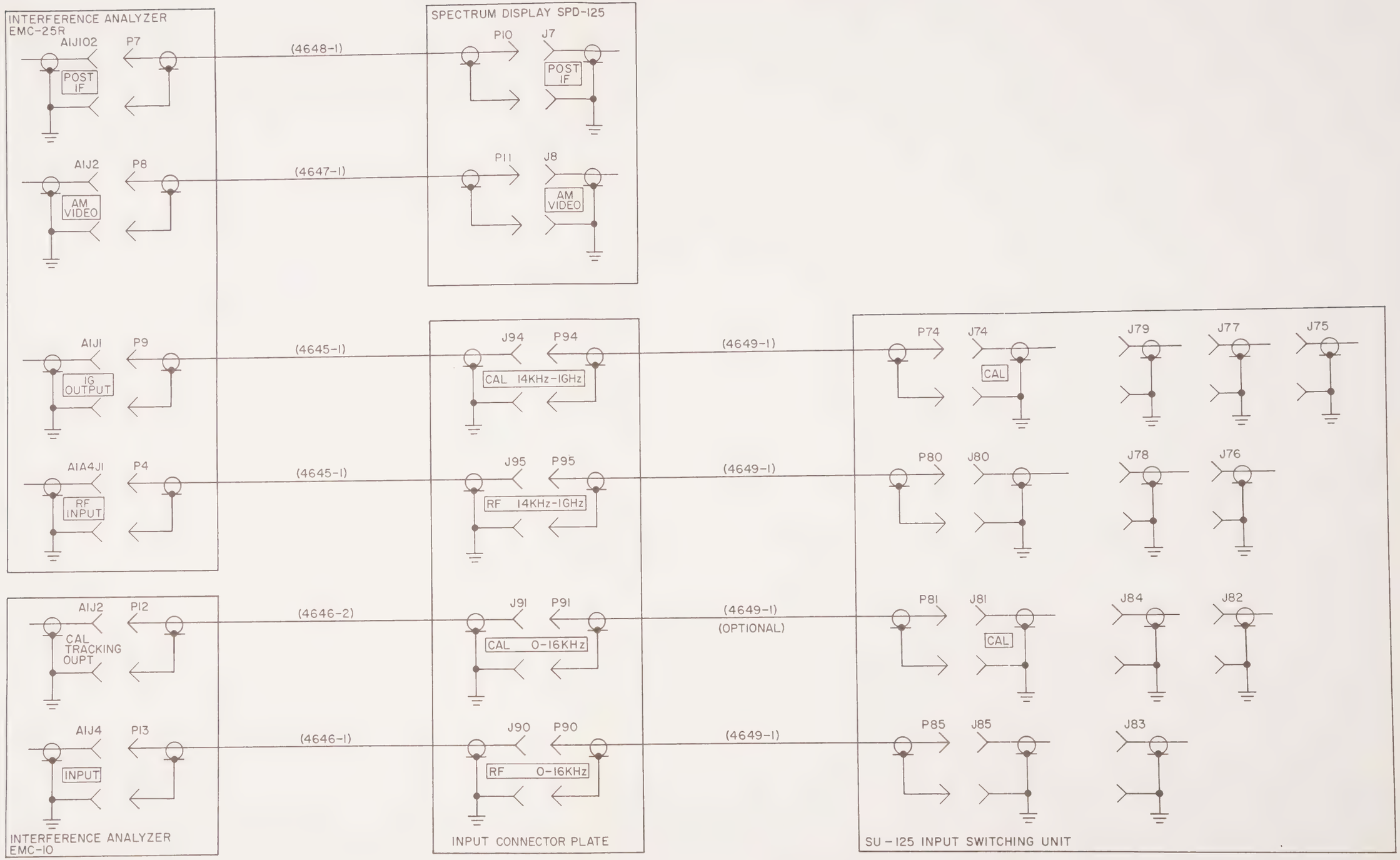


Figure 6.6 FSS-250, R.F. Cabling Diagram

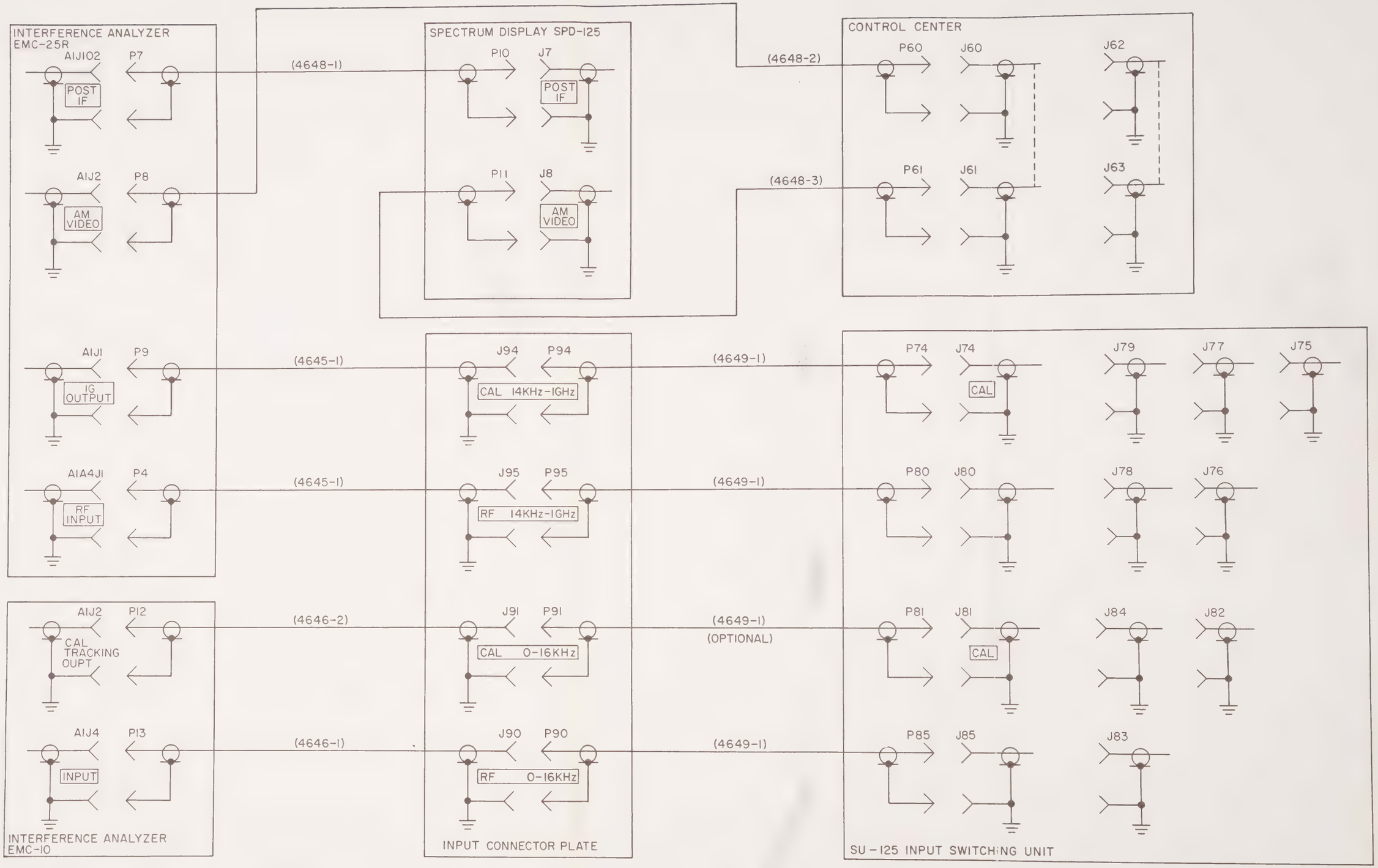
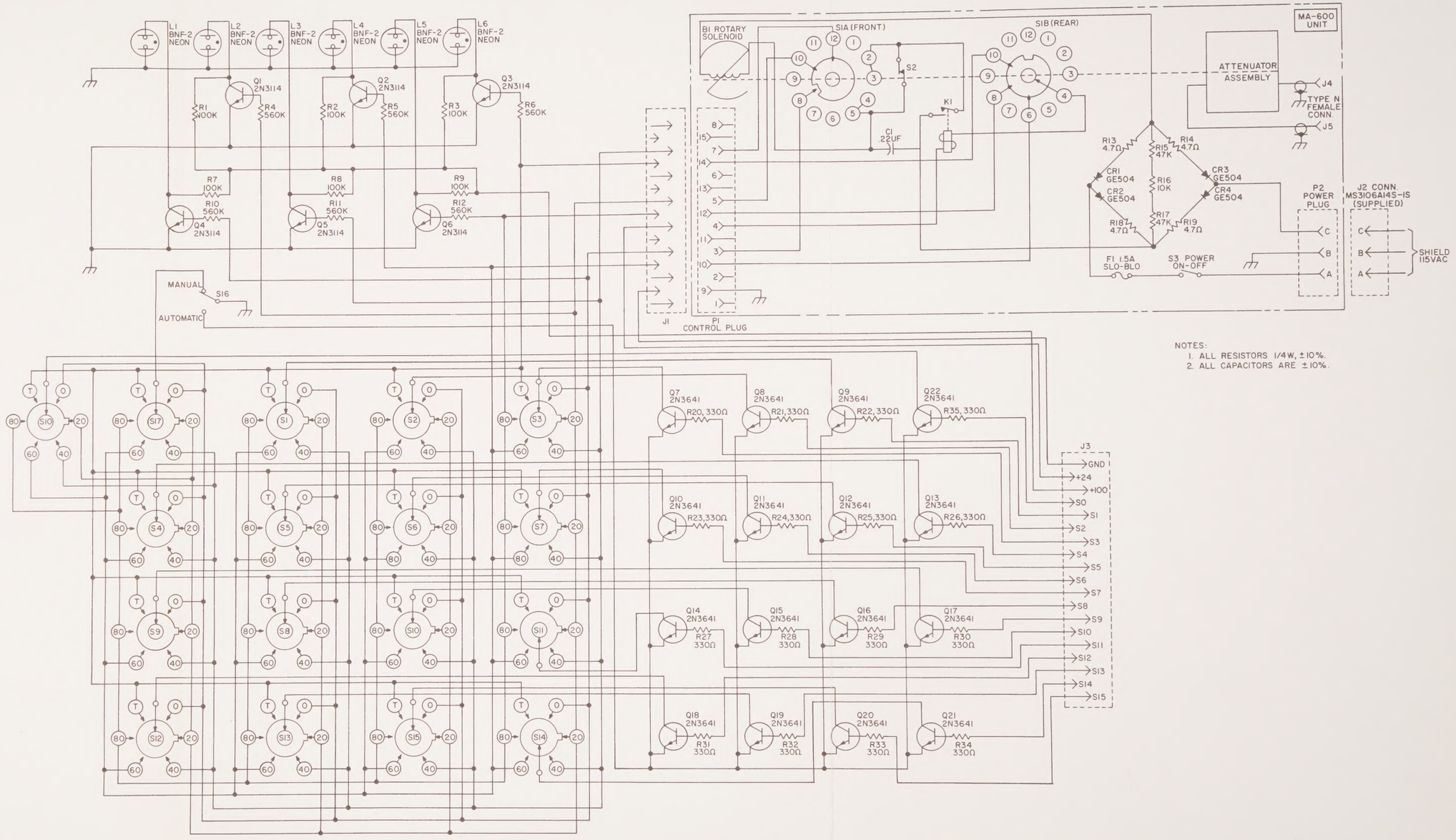


Figure 6.7 FSS-250D, R.F. Cabling Diagram



NOTES:
1. ALL RESISTORS 1/4W, ±10%.
2. ALL CAPACITORS ARE ±10%.

Figure 6.8 Attenuator, PSA-125, Schematic Diagram

Warranty

Electro-Metrics Corporation warrants that the articles delivered under each purchase order or contract will be free from defects in material or workmanship, under normal use and service, for a period of one year from the date of delivery to the Buyer. Electro-Metrics' obligations under this paragraph are limited, at its option, to repairing or replacing with reasonable promptness, such articles which are returned to Electro-Metrics' factory at Amsterdam, New York, transportation charges prepaid, and which, after examination are disclosed to Electro-Metrics' satisfaction to be thus defective. Semiconductors, electron tubes, fuses and batteries are excluded from liability. The provisions of this paragraph are effective only if a claim is made in writing to Electro-Metrics with the relevant information with respect to the alleged defect, within thirty (30) days following discovery of said defect.

The foregoing provisions of this warranty shall be effective only if the articles delivered under this purchase order or contract have been maintained, repaired, handled, utilized and stored in accordance with Electro-Metrics written instructions relating thereto and have not been subjected to misuse, improper installation, negligence, or accident. The provisions of this Warranty Clause are in lieu of all other warranties, expressed or implied, and of all other obligations or liabilities on Electro-Metrics' part and it neither assumes nor authorizes any other person to assume for Electro-Metrics any other liabilities in connection with the sale of the said articles. In no event shall Electro-Metrics be liable for any consequential or special damages.

Vice President, General Mgr.

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